Bulletin

Wyoming Agricultural Experiment Station, University of Wyoming. Agricultural Extension Service


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UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

INDEX BULLETIN B.

JULY, 1898.

Index to Bulletins Twenty-Seven to Thirty-Seven,

JULY, 1896–JUNE, 1898.

BY THE SECRETARY.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

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LIST OF THE BULLETINS AND ANNUAL REPORTS

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LARAMIE, WYOMING,

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SECOND ANNUAL REPORT, 1892.

General statement with Bulletins Ncs. 5 to 10. A. A. Johnson, Director.

Bulletin No. 11—February, 1893. Crop reports for 1892. A. A. Johnson, Director, and F. J. Niswander, Superintendent Laramie Farm.

" No. 12—April, 1893. Ground Squirrels (Gophers). F. J. Niswander, Entomologist.

" No. 13—July, 1893. The Feeding and Management of Cattle. W. A. Henry, Ph. D., University of Wisconsin. (Reprint by Permission).

" No. 14—October, 1893. Geology of the Wyoming Experiment Farms, and Notes on the Mineral Resources of the State. W. C. Knight.

" No. 15—December, 1893. The Winter-Killing of Trees and Shrubs. Aven Nelson, Botanist.

" No. 16—December, 1893. Grasses and Forage Plants. B. C. Buffum, Horticulturist.

THIRD ANNUAL REPORT, 1893.

Progress of Station Work, with Bulletins Nos. 11 to 16. A. A. Johnson, Director.

Bulletin No. 17—March, 1894. I. Crop Report for 1893. II. Cost and Profit of Growing Wheat. III. Sugar Beets. IIII. Garden Vegetables and Tobacco. V. Meteorology for 1893. B. C. Buffum, Horticulturist, and E. E. Slosson, Chemist.

" No. 18—June, 1894. I. Reclamation of Arid Lands. II. The Harvey Water Motor. A. A. Johnson, Director.

" No. 19—September, 1894. Squirrel Tail Grass (Fox-Tail); One of the Stock Pests of Wyoming. Aven Nelson, Botanist.

" No. 20—October, 1894. The Artesian Wells of Southern Wyoming. J. D. Conley, Physicist.

FOURTH ANNUAL REPORT, 1894.

Reports from the Departments, and Bulletins Nos. 17 to 20. A. A. Johnson, Director.

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" No. 23—May, 1895. Notes on Climate. J. D. Conley, Meteorologist.

" No. 24—August, 1895. Water Analyses. E. E. Slosson, Chemist.

" No. 25—November, 1895. Results of Three Years' Experiments in Cost and Profit of Growing Wheat. B. C. Buffum, Agriculturist.

" No. 26—December, 1895. Garden Peas. B. C. Buffum, Agriculturist and Horticulturist.

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Bulletin No. 27—March, 1896. Meteorology for 1895, and Notes on Climate from 1891 to 1896. J. D. Conley, Meteorologist.

" No. 28—May, 1896. First Report on the Flora of Wyoming. Aven Nelson, Botanist.

" No. 29—July, 1896. Alkali. B. C. Buffum, Agriculturist.

" No. 30—September, 1896. Stock Feeding Experiments at Lander. B. C. Buffum, Agriculturist.

" No. 31—December, 1896. The Worst Weeds of Wyoming and Suggested Weed Legislation. Aven Nelson, Botanist.

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" No. 33—June, 1897. The Composition of Prepared Cereal Foods. E. E. Slosson, Chemist.

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" No. 35—December, 1897. Mechanical Analyses and Water Content of Wyoming Soils C. B. Rigdaway, Physicist.

" No. 36—April, 1898. Wyoming Sugar Beets. E. E. Slosson, Chemist.

" No. 37—June, 1898. Stooling of Grains. B. C. Buffum, Agriculturist.

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UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

BULLETIN NO. 27.

MARCH, 1896.

METEOROLOGY FOR 1895,

AND

NOTES ON CLIMATE FROM 1891-1896.

BY THE METEOROLOGIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

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METEOROLOGY FOR 1895,

AND

NOTES ON CLIMATE FROM 1891-1896.

BY J. D. CONLEY.

The Experiment Station commenced its meteorological observations in the early part of 1891, and has issued a report each year, the first one being quite extensive, figuring most of the apparatus used in the department, and explaining its use. After the first Bulletin, this, the fifth report, seems of the greatest importance, since we have sufficient data to make an intelligent comparison and formulate for all practical purposes a general idea of the climatology of the various regions of the State, from which we have observations reported to us monthly. While it takes 20 years, or more, to establish accurate scientific data as to the climatology of any region, yet the careful comparison of the observations of temperature, rainfall, directions and velocity of the wind, etc., will give so near the normal conditions in these respects, that one will be enabled to form an intelligent opinion of the climatology of the northern, eastern, central and southern portions of our State, the regions from which we have had regular reports for the past five years.

There is such a close relation existing between crops and climate and soil, that the Meteorology and Soil Physics come under the Weather Division of the Agricultural Department of the Government.

The study of Meteorology does not consist of comparing dry tables of facts and statistics, but the study of such authors as Flammarion on the Atmosphere, and Ferrel on the Winds, is as interessing, instructive and fascinating as our most popular literary works, even from a rhetorical standpoint. Davis' Elementary Meteorology, American Weather by General Greeley, Climatology and Time, and Climate and Cosmology by Croll, show what rich fields of thought and depth of research the Science has investigated, and is still pursuing. We can hardly estimate the great advantages of the Signal Stations scattered throughout the country, giving to the farmer, the shipper, and to the community at large, due warning of approaching storms and cold waves, so that preparation can be made for their reception.

We have suggested that there is a close relation existing between Climatology and crops. The experiments on our farm at Laramie (altitude 7,200 feet, the highest altitude of all the Experiment Stations of the United States) together with the weather reports, form rather an unique experiment in itself, among the group of Stations. One studying the weather report alone, would predict a poor crop; but our Museum in the Agricultural Department of the University has as fine a display of cereals and root crops from the Laramie plains, as can be produced in the United States. The fact has been established that the nights are too cold during July and August for corn, yet roasting ears have been grown at Laramie.

But our Museum illustrates to the world what can be done in the way of agricultural products, and the study of our Annual Crop Reports illustrates the wonderful influence of the weather over the crop reports for the various

seasons, the crops varying with the fluctuations of the weather.

The automatic apparatus that we have added to the department within the past two years for recording the directions and velocity of the wind is of such excellence and interest that we give herewith a cut and description. The first Bulletin issued on Meteorology was in 1891, in which were figured most of the instruments used for taking observations. That issue being nearly exhausted, it is thought best to give the figures in this issue, together with the interesting apparatus that has been added since 1891.

We feel that a few general remarks in regard to the weather will not be out of place here, for this Bulletin will fall into the hands of many who have not lived in an arid region, and in reading the tables in regard to climate, rainfall, velocity of the wind, etc., will form an absurd idea as to the real conditions of the weather as experienced by the inhabitants of such regions.

The statement is not too strong when we say that the climate of June, July and August is the most delightful of any region in the United States.

While our Winter temperature will average a little colder than that of New England, New York and Illinois, yet the high altitude and the consequent rareness and dryness of the atmosphere more than counterbalance the difference in temperature. While the weather is from 10 to 20 degrees colder here in the winter than in the above named States, yet it feels much warmer.

It is the unanimous verdict of persons who have come from said regions that our winters are much pleasanter,

due to the dryness of the atmosphere, and that our winters seem much warmer.

On the very coldest days the atmosphere is still and dry and clear. But when there is an east wind, laden with moisture, it is apparently from 10 to 20 degrees colder than the real temperature indicates.

In order to predict what the weather is going to be, even within twenty-four hours, the following data is essential—whether the barometer is rising or falling, the temperature, the dew point, the relative humidity, and the direction of the wind. These facts will enable a careful observer to foretell with a considerable degree of certainty what will be the condition of the weather for several hours in advance.

We insert some simple and general laws in regard to the movements of the barometer:

The barometer is high when the air is cold, and when the air is dry.

The barometer is high when the lower stratum of air is heated, when the air is damp, when the air has an upper movement.

We therefore observe that the rising and falling of the barometer alone is not sufficient data from which to foretell the conditions of the weather.

The following taken from the United States Department of Agriculture Weather Bureau, under "Instructions for Voluntary Observers," is of such general practical value that we publish it here, hoping that some observers will volunteer to send us information in regard to some, if not all, the questions asked. All of the points are of great importance in working out the problem of the agricultural possibilities of our new commonwealth.

GENERAL PHENOMENA OF CLIMATE.

Information of a general character relating to the growth of plants will be of value in compiling the Climatology of a district. It is suggested that where voluntary observers can do so, the following be included in their records:

Time of plowing in the spring.

Time of planting various crops.

Time of appearance of same above ground.

Time of flowering of strawberries, currants, raspberries, apples, plums, and other fruit.

Time of commencement of haying.

Time of commencement of harvesting the various cereals.

Time of ripening of various fruits.

Time of first killing frost in the fall.

Time of last killing frost in the spring.

Time of sowing fall wheat.

Time of appearance of earliest shoots of same above ground.

Time of last snow on the ground.

The depth of snow on the ground on the last day of each winter month.

The time of migration of wild fowls and birds, the flights north and south.

The time of leafing and fall of leaves in deciduous forests.

The date of breaking up of ice in large rivers; in bays.

The date of greatest rise and lowest water in important streams.

Voluntary observers are requested to include in their

monthly reports all reliable information relative to the destruction of life and property, coming to their knowledge, due to the storms, classifying it, as far as possible, as indicated in the following, viz:

Date of storm, nature of storm (tornado, northeast gale, etc.), section of country traversed by the storm; number and names of persons killed; number and names of persons injured; number of houses, barns and other buildings destroyed or damaged, with estimated amount of loss; estimated amount of damage to property; number of animals killed and estimated value.

A tornado has never been known in Wyoming, and from the physical conditions which produce them it is probable they never will be. Their origin is to the east of us. While our records show sometimes a high velocity of the wind, still there is hardly ever any damage produced by it, on account of the extreme lightness of the atmosphere, the pressure at Laramie being 11.3 pounds, against 14.7 pounds at sea level.

The wind moving at the rate of 36 miles per hour at Laramie has less than three-fourths the force or power of the wind moving at the same rate at the level of the sea.

INSTRUMENTS USED.

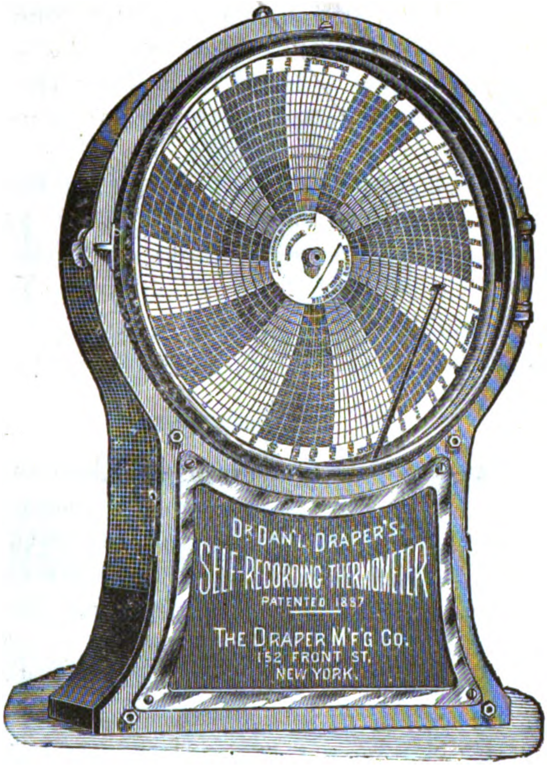

FIG. 1.—Draper's Self-Recording Thermometer.

This instrument records the temperature by means of clock-work, on large paper dials which are kept on file so that we can see the slight or sudden changes for every minute of the day. While its readings do not agree exactly with the thermometers, yet by comparing the self-registering with the observations taken by the other thermometers, we

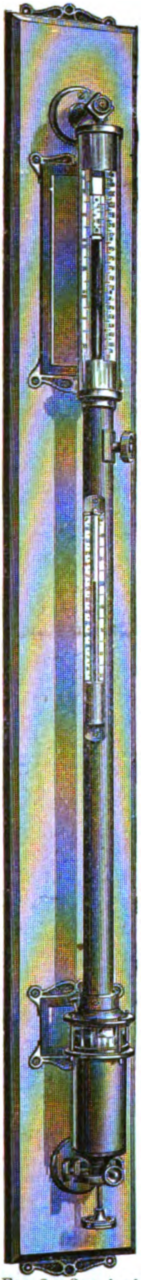

FIG. 2.—Standard Barometer.

can find within a degree Fahrenheit the temperature for any hour of the day for the last five years.

The readings from the Standard Barometer (Fig. 2) are taken twice each day, viz., at 7 a. m. and 7 p. m. The average monthly readings are found in Table IV.

Besides this barometer we have the Richards Self-Registering Aneroid Barometer.

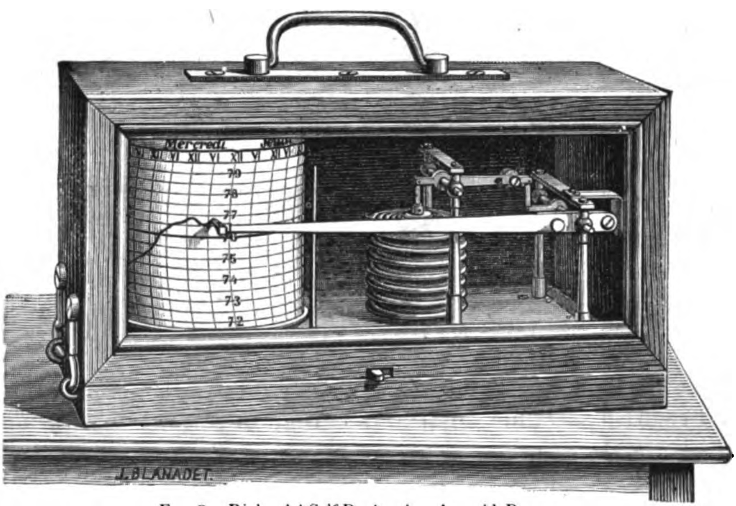

FIG. 3.--Richards' Self-Registering Aneroid Barometer.

While this instrument, like the Draper's Self-Recording Thermometer, is not as accurate as the standard instruments, yet it has the advantage of recording the barometric reading of every minute of the day, so that one can see just the time of any change; which, on being compared with the standard barometer, gives close approximate results.

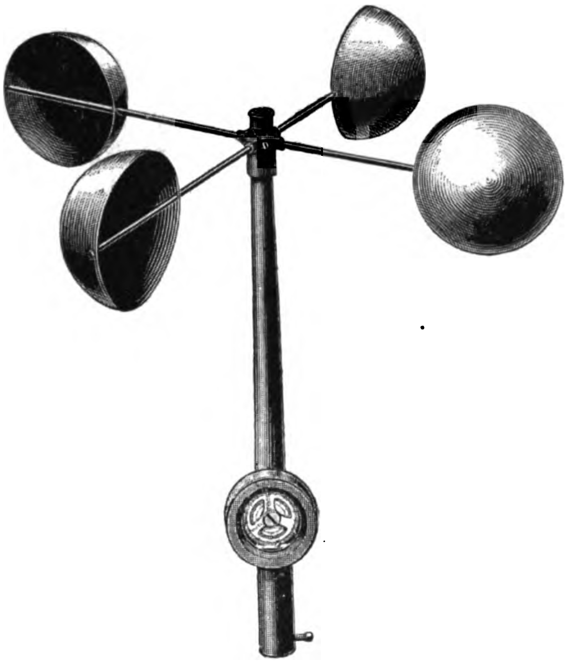

FIG. 4.—Robinson's Anemometer.

This instrument is of such great importance that a more detailed account of it is given than of the others thus far mentioned.

The following description is taken from Bulletin No. 4 of this Station, on Meteorology:

"Robinson's Anemometer is an instrument designed to measure the number of miles and the velocity of the wind. The size of the cups and the length of the arms are such that three miles of wind passing causes the center of the cups to travel one mile. This ratio varies with

the velocity of the wind. According to Greeley, at great velocities it is less than three to one, and more wind is registered than really blows. This is probably true at this place, where we have so much wind, though the error is not likely to be more than 15 or 20 per cent at any time. It is also possible that there is an error due to elevation, the air here being more rarefied and consequently exerting less pressure on the vanes; its amount could only be determined by experiment. It would tend, however, to counterbalance the former error. The vanes and cross-bars are of aluminum, which gives lightness and durability. These are connected with a rod and endless screw to the cog wheels which turn the dial."

The anemometer and wind vane are on a steel tower 70 feet high, and 300 feet away from the University, connected by means of insulated copper wires with the self-registering apparatus, a description of which is as follows:

THE QUADRUPLE REGISTER.

This self-registering apparatus, made by Julien P. Friez, of Baltimore, is the most interesting instrument in the Meteorological Department. It consists principally of a fine eight-day clock that revolves a brass drum six inches long and five inches in diameter, around which a blank register is wound. As the name quadruple signifies, it is constructed to register four different measurements at once, viz.: The velocity of the wind; the direction, whether north, south, east or west; it will also record the percentage of sunshine and the amount of rainfall.

The necessary attachments for sunshine and rainfall have not been secured yet. We use it for the velocity and the direction of the wind, but hope in the near future to

add the other two attachments. At present there are two automatic pens, worked by electricity, registering the velocity of the wind, also its direction for every minute of

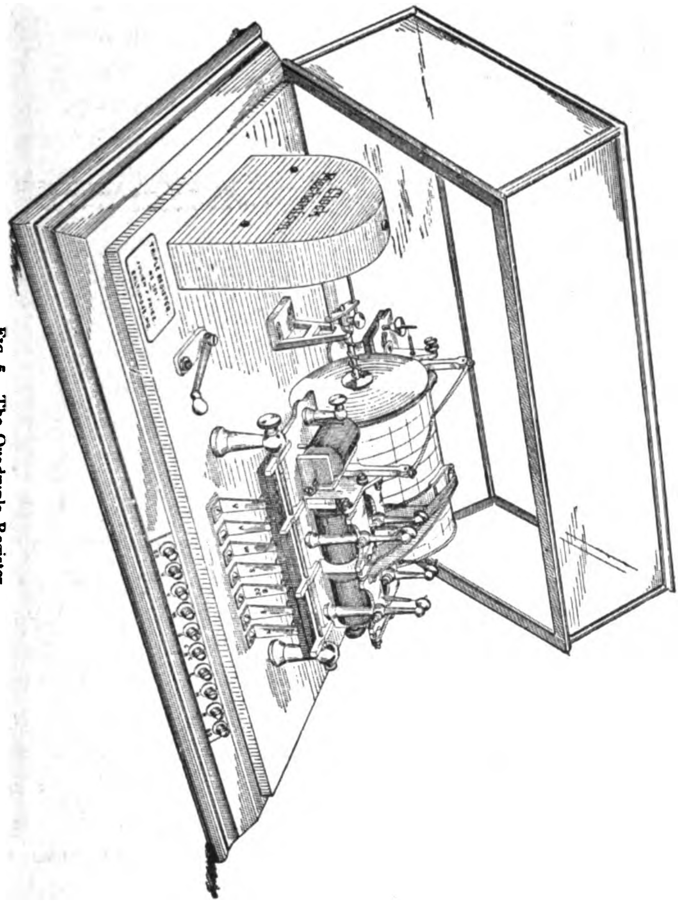

FIG. 5.—The Quadruple Register.

the twenty-four hours of the day. A blank register is placed upon the brass drum at noon each day. Thus there is recorded, on these records kept on file, a complete

history as to the direction and velocity of the wind, as well as the total number of miles traveled by the wind.

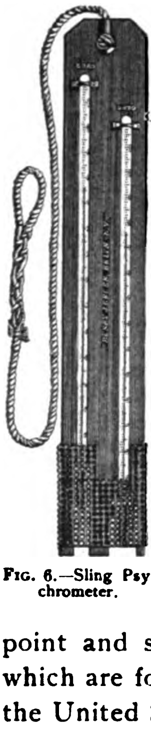

Fig. 6.—Sling Psychrometer.

Fig. 6 is a Sling Psychrometer, an instrument by means of which the relative humidity and dew-point are determined. It consists of a metallic frame upon which are two mercurial thermometers. The bulb of one of these is covered with a piece of linen fitting it closely. To read the instrument the linen-covered bulb is wet with clear water, and by means of the string attached to the framework the instrument is swung in the air. The evaporation from the covered bulb cools it, and its lowest reading is taken, at the same time reading the dry bulb thermometer. The difference between the two bulbs gives the means of determining the dew-point and saturation of the air of humidity, which are found in printed tables furnished by the United States Weather Bureau.

Fig. 7.—Soil Thermometer.

Fig. 7 is a Soil Thermometer. It is a mercurial thermometer encased in wood, adapted to different depths in the ground, viz., three inches, six inches, twelve inches, twenty-four inches, thirty-six inches and seventy-two inches. The temperatures recorded by these instruments are given in Table III. The lowest temperature of the deepest thermometer, six feet below the surface, was 34.3 ° F. on March 2, only about two degrees

above the freezing point. a practical fact for plumbers to notice and keep their pipes at least six feet below the surface.

FIG. 8.—Terrestrial Thermometer.

Fig. 8 is a Terrestrial Thermometer. It is a minimum alcohol thermometer, the stem being enclosed for protection. It is kept about six inches from the ground. The radiation, or amount of heat lost by the earth, is shown by the difference of its reading and that of the minimum thermometer. For example, the coldest day of 1895 was on February 12, when the thermometer ten feet from the ground was —29.5 ° F.; the temperature registered by the terrestrial thermometer was —38.5 ° F., being nine degrees colder than ten feet above the ground. This difference is called terrestrial radiation.

Fig. 9 is a steel tower situated 300 feet from the main University building; it was erected for the support of the anemometer and the wind-vane. It is 70 feet high, thus lifting those important instruments above the counter currents and atmospheric interferences caused by the University tower. It is connected by wires with the Meteorological Department, where the direction and velocity of the wind are recorded.

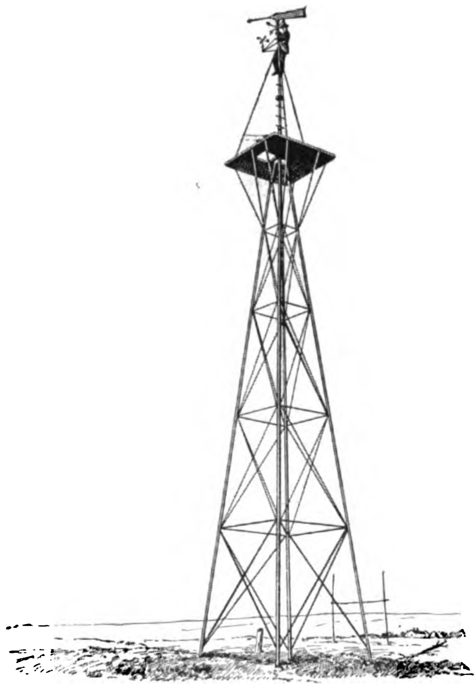

FIG. 9.—Steel Tower.

MAXIMUM AND MINIMUM THERMOMETERS.

These are self-registering. The maximum is a mercurial thermometer with a constriction in its tube near the base. It is mounted horizontally and the mercury which passes the small place in the tube does not go back into the bulb of the thermometer when it cools. The upper end of the column gives the reading of the warmest temperatures since the instrument was last set. The minimum is an alcohol thermometer with a small steel index in the alcohol in its tube. As it cools the surface tension of the alcohol pulls the index down, but as the

temperature rises the alcohol goes up, leaving the top of the index in the position of its lowest point, which gives the reading of the lowest temperature since the instrument was last set.

EVAPORATION AT LARAMIE.

Evaporation from water surface is measured by means of a hook-gauge, measurements being taken every day that the water is not frozen. A tank of galvanized iron holding one cubic meter of water is used. Evaporation can not be accurately obtained during the winter months, there being only a little over six months of the year that water does not freeze so as to interfere with the record. For six months, from April 17 to October 22, it was 37.020 inches. During the time the water was not frozen the evaporation was as follows:

April 17 to 30	2.530 inches
May	7.334 inches
June	6.236 inches
July	7.294 inches
August	6.066 inches
September	4.944 inches
October	2.616 inches

OBSERVERS.

The observations are kept by the superintendents of the farms. (See the reports of the various farms.) Besides these are the the following voluntary observers, viz.: Mrs. C. M. Cheeney of Bates' Park (Freeland), Natrona County; Martin J. Gothberg, Dobin Springs, near Cas-

per, Natrona County; Andrew Falconer, Hat Creek, Converse County; Lafayette Johnson, Little Horse Creek, Laramie County; A. E. Bridger, Sybille, Albany County. The observations at Laramie were made by the Assistant Meteorologist of the Experiment Station, Fred Nelson, who resigned in October, 1895. James P. Cowan was then elected assistant. Thanks are due to all these observers for the interest taken and the time spent in taking the observations and furnishing the records.

EXPLANATION OF THE TABLES.

The mean temperature is given from the maximum or highest and minimum or lowest temperature for each day. The daily range is the difference between these readings. In the relative humidity or per cent of saturation and dew-point tables, the computations are made from the readings of the sling psychrometer, which gives the dry and wet bulb temperatures. They have been computed from the tables in the report of the Chief Signal Observer for 1886, except where the difference between the wet and the dry bulbs is greater than those given, in which instances the tables of Guyot have been used, correcting for altitude in each case. The relative humidity is the per cent of moisture in the air, taking the whole amount the air could hold at the time as 100. The dew-point is the temperature at which this moisture would be precipitated should the air cool to that point. The barometer readings are corrected for temperature from Guyot's tables, each reading being reduced to 32° F. The terrestrial radiation, or the amount of heat the earth loses during the night, is given from the differ-

ence in the readings of the terrestrial thermometer, placed six inches above the ground, and the minimum thermometer. It will be noticed that it sometimes occurs that it is warmer near the ground than at the minimum thermometer kept ten feet above the ground. This usually happens on cloudy nights, or when the terrestrial is covered with snow, when little or no heat is lost by the earth. The soil temperatures are taken twice daily, at 7 a. m. and 7 p. m. The soil thermometers are located on the lawn at the University, and give the temperature of the ground. They are about 100 feet from ground that is irrigated, but not near enough to be influenced by the moisture therefrom. The air temperatures given in these tables are from the 7 a. m. and 7 p. m. readings.

A light frost occurred on July 13, 1891, and a damaging frost on August 22. Light frosts occurred on June 5, 6, 7 and 13, in 1892: a killing frost on Aug. 29. Killing frosts occurred on June 6 and August 16, 1893. There were light frosts on May 24 and 25, 1894. In 1895 a killing frost occurred on June 18th; hail on June 6th. July 17th and 31st; several light hailstorms in August.

Table I. **TEMPERATURE.** **1895.**

PLACE.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
Laramie.	20.5	17.9	27.5	40.0	45.3	52.2	58.8	61.6	54.5	40.9	27.0	15.3	38.5
Lander	19.8	21 0	31.9	46.2	50.0	53.6	65.4	65.2	55.5	48.1	28.1	20.6	42.1
Saratoga	17.2	17.3	27.1	41.4	......	......	......	......	......	......	......	......	†25.7
Sheridan	14.5	13.8	29.4	47.6	51.2	56.6	63.7	63.4	54.3	45.3	29.1	26.8	41.3
Sundance.	17.7	14.7	27.3	46.0	48.8	55.6	64.6	64.4	55.4	44.3	28.1	21.7	40.7
Wheatland	......	......	......	......	54.7	60.6	70.4	72.0	66.7	55.3	38.7	29.6	‡57.3
Freeland	......	......	......	41.2	47.2	53.5	60.3	62.7	54.0	39.5	24.8	18.6	‖44.6
Little Horse Creek	20.4	......	28.9	46.1	54.9	59.5	65.8	67.7	60.7	41.7	30.1	22.9	§45.3
*Dobin Springs	......	......	30.3	42.8	54.2	63.3	71.9	72.8	64.0	47.9	33.4	26.0	**50.7

*Thermometer broken. †For January, February, March and April. ‡From May to December. ‖Not including January, February and March §The average for all except February. **Average omitting January and February.

Table II. **MONTHLY RANGE OF TEMPERATURE.** **1895.**

PLACE.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
Laramie.	19.0	23.6	21.8	25.4	22.4	25.5	26.6	28.1	31.5	29.5	25.0	19.9	24.9
Lander.	27.7	29.3	23.0	19.6	29.4	29.5	21.2	29.3	29.3	28.9	22.6	24.5	26.2
Saratoga	22.0	25.4	24.7	27.0	......	......	......	......	......	......	......	......	*24.8
Sheridan	25.3	27.8	24.3	31.9	27.9	24.2	33.5	32.1	32.5	35.4	27.3	32.1	29.4
Sundance	19.4	21.7	20.7	21.0	23.5	24.0	30.1	28.3	27.6	25.4	18.7	16.6	23.1
Wheatland	......	......	......	......	28.5	25.2	27.2	30.1	27.5	35.1	32.6	23.5	†28.7

*For January, February, March and April. †From April, 8 months.

Table III. Weekly Means of Soil Temperatures, Laramie, 1895.

Week Ending	Air Temperature	3 Inches	6 Inches	12 Inches	24 Inches	36 Inches	72 Inches
January 5	18.2	22.6	23.0	24.7	28.7	32.2	39.9
12	21.1	23.0	24.2	25.8	27.7	31.6	38.7
19	25.0	27.2	27.8	28.5	30.0	32.0	38.0
26	15.7	21.2	23.9	26.3	29.5	31.8	37.5
February 2	7.5	15.9	17.6	20.5	26.1	29.6	36.7
9	16.1	24.2	24.9	24.4	26.7	29.0	35.9
16	—7.7	12.4	14.7	18.7	24.7	28.2	35.1
23	29.1	26.3	25.5	23.7	24.7	27.1	34.7
March 2	27.5	32.4	32.7	30.8	29.5	29.8	34.3
9	20.6	29.0	29.5	29.3	30.0	30.7	34.4
16	14.7	29.5	29.9	30.5	31.1	31.6	34.7
23	29.2	32.4	32.9	31.5	31.2	31.9	35.1
30	39.0	42.2	42.0	39.2	35.8	34.7	35.6
April 6	27.1	34.1	35.0	35.9	36.4	36.5	36.7
13	37.7	40.8	40.7	38.2	37.1	36.0	37.2
20	42.1	47.1	47.2	45.1	42.6	40.2	38.0
27	44.5	50.1	50.1	47.6	45.2	42.8	39.6
May 4	42.5	47.8	48.7	48.4	47.5	45.7	41.3
11	49.3	52 4	52.7	50.6	48.2	46.2	42.5
18	47.4	54.3	55.5	53.6	51.2	49.1	43.8
25	47.0	53.1	54.0	53.0	51.4	49.8	45.1
June 1	46.6	50.5	52.1	52.2	51.8	50.6	46.1
8	46.6	50.3	50.4	48.8	48.6	48.0	46.3
15	56.3	58.8	58.3	55.4	52.9	50.8	46.6
22	63.3	60.4	60.8	58.3	56.6	54.3	48.2
29	56.9	64.5	64 5	62.0	59.5	56.6	49.7
July 6	62.4	66.5	66.2	63.3	60.5	57.8	51.3
13	49.1	59.7	60.8	60.8	60.2	57.2	52.4
20	61.7	63.1	63.1	61.1	59.3	57.4	52.8
27	62.7	65.3	65.2	62.7	60.5	58.3	53.2
August 3	60.5	65.4	65.9	64.3	62.5	60.2	54.0
10	60.8	67.1	67.4	65.4	63.2	60.8	54.7
17	62.9	68.0	67.7	65.2	63.1	60.9	55.2
24	60.0	65.8	66.2	64.9	63.4	61.1	55.7
31	58.3	63.0	63.7	62.8	61.9	60.6	55.9
September 7	55.4	63.4	63.5	61.8	60.6	59.4	55.6
14	61.4	64.3	64.2	62.4	60.9	59.4	55.6
21	53.5	62.7	62.9	62.2	60.7	59.5	55.5
28	43.1	54.3	54.1	53.1	55.5	56.1	55.1
October 5	40.7	52.1	52.7	53.6	54.3	54.4	54.0
12	42.6	50.0	49.4	50.2	50.0	51.1	52.8
19	39.3	48.9	49.4	49.6	49.8	50.2	51.5
26	32.5	40.1	42.4	44.0	47.0	48.1	50.5
November 2	34.9	36.2	38.3	39.9	43.0	44.8	49.0
9	24.0	31.9	33.6	37.0	40.2	42.5	47.5
16	27.9	31.1	33.2	34.3	37.3	39.7	45.9
23	25.3	32.6	34.0	35.7	37.8	39.3	44.5
30	20.3	25.8	27.5	30.5	34.5	37.1	43.4
December 7	18.8	24.0	25.1	28.0	32.2	34.9	42.1
14	28.9	30.4	30.0	29.9	32.1	34.1	40.8
21	17.4	22.1	24.5	26.6	30.6	33.2	39.8
28	10.7	18.5	21.1	24.1	27.8	30.6	38.7
Summary	1968.4	2274.8	2310.7	2296.4	2313.6	2315.5	2339.2
Mean	37.9	43.7	44.4	44.2	44.5	44.5	45.0

Table IV. LARAMIE. 1895.

Month.	Relative Humidity. Highest	Relative Humidity. Lowest	Relative Humidity. Mean	Dew-Point. Highest	Dew-Point. Lowest	Dew-Point. Mean	Barometer. Highest	Barometer. Lowest	Barometer. Mean	Wind. Greatest Velocity	Wind. Miles	Wind. Direction	Terrestrial Radiation. Highest	Terrestrial Radiation. Lowest	Terrestrial Radiation. Mean
January	95.5	39.8	62.8	25.4	—16.0	6.9	23.210	22.590	22.848	56 miles	10,389	SW	7.7	1.0	3.9
February	100.0	25.7	68.0	27.6	—29.5	5.7	23.254	32.756	22.985	44 "	8,507	SW	9.0	.8	4.4
March	100.0	24.5	59.4	32.7	—6.2	11.3	23.306	22.508	22.922	48 "	12,047	SW	8.0	.4	3.6
April	100.0	15.7	57.2	37.2	0	22.6	23.402	22.576	23.048	57 "	9,111	NW	5.8	0	2.8
May	100.0	15.8	55.5	41.2	15.0	28.9	23.370	22.468	23.014	40 "	10,222	NW	5.6	.2	2.8
June	100.0	20.7	55.1	49.8	13.0	35.3	23.272	22.911	23.137	40 "	8,511	SE	8.0	0	4.1
July	89.2	22.3	56.9	54.5	26.8	42.0	23.339	23.009	23.174	54 "	7,040	SW	9.0	.2	4.0
August	100.0	26.1	55.7	58.0	28.2	42.8	23.368	22.964	23.215	42 "	7,365	SE	8.7	.7	4.0
September	91.0	17.0	50.4	57.7	13.5	31.5	23.387	22.777	23.119	56 "	8,989	SW	8.0	1.9	5.5
October	89.8	20.7	60.2	63.0	6.0	25.7	23.351	22.921	23.167	36 "	6,917	SW	8.5	0	5.6
November	100.0	15.6	61.1	63.0	—24.5	16.3	23.277	22.682	23.004	48 "	8,043	SW	13.0	0	4.9
December	100.0	24.0	59.6	27.2	—15.0	7.9	23.301	22.535	22.960	48 "	11,000	SW	11.0	0	3.2
Summary			701.9			275.9			276.593		108.741				48.8
Mean			58.5			23.0			23.049		9,060.9	SW			4.07

Table V. PRECIPITATION. 1895.

Place.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Laramie	0.08	0.14	0.43	0.87	2.09	2.12	2.71	1.17	0.18	0.74	0.32	0.33	11.15
Lander	0.75	0.75	1.32	5.48	2.32	2.03	0.61	1.28	2.26	0.89	1.97	0.00	19.66
Saratoga	0.70	0.55	3.30	1.00	......	......	......	......	......	......	......	......	*5.55
Sheridan	1.60	0.90	0.85	2.25	1.88	3.19	0.57	1.44	1.19	0.57	0.95	0.25	15.64
Sundance	1.20	2.10	2.50	1.48	3.47	5.25	1.35	0.45	0.75	0.47	2.72	2.10	23.84
Wheatland	......	......	......	......	4.30	3.20	1.46	0.00	0.60	2.00	0.80	0.70	†13.06
Freeland	......	......	......	1.71	0.44	1.80	‖2.80	0.55	1.50	0.05	1.50	1.45	‡11.80
Dobin Springs	1.60	0.60	3.40	2.50	1.45	2.38	2.41	0.45	1.50	0.40	1.00	0.75	18.44
Little Horse Creek	0.02	0.05	0.13	3.60	1.38	2.48	1.87	0.54	1.90	0.00	0.25	0.00	12.22

*First four months. †Eight months, commencing with May. ‡Nine months, omitting January, February and March. ‖1 inch hail.

Summary for 1895.

Highest Temperature.

Laramie, 87°, July 27; Lander, 89°, July 26; Sheridan, 95°, August 15; Sundance, 94°, July 22 and 23; Wheatland, 101°, July 27.

Lowest Temperature.

Laramie, —30°, February 12; Lander, —26°, February 11; Sheridan, —38°, February 7; Sundance, —31°, February 7; Wheatland, (instrument broken); Saratoga, —35°, February 11.

Highest Monthly Range of Temperature.

Laramie, 31.5°, for September; Lander, 31.5°, June; Sheridan, 35.4°, October; Sundance, 25.4°, October; Wheatland, 35.1°, for October (only eight months reported.)

Lowest Monthly Range of Temperature.

Laramie, 19°, for January; Lander, 19.6°, for April; Sheridan, 24.2°, for June, also 24.3° in March; Sundance, 16.6°, in December; Wheatland (for eight months), 23.5°, in December.

The highest annual mean temperature was at Lander, 42.1°.

The lowest annual mean temperature was at Laramie, 38.5°.

The average annual mean temperature for the following four farms, Laramie, Lander, Sheridan and Sundance, was 40.7°.

The greatest annual precipitation was at Sundance, 23.84 inches.

The lowest annual precipitation was at Laramie, 11.15 inches.

The average precipitation for the four farms and Dobin Springs and Little Horse Creek was 16.84 inches.

Other Observations at Laramie.

Highest terrestrial radiation, 15.5°, November 27; lowest terrestrial radiation, 0.0°, April 5, 15, 26, June 3, October 4, November 17, 23, 25, and December 20.

Lowest relative humidity, 15.7, on April 25; mean relative humidity for the year, 58.5.

The highest dew-point was 54.5°, on July 30; the lowest on December 29, —15°; the mean dew-point for the year was 23°.

The greatest monthly evaporation was in July, 7.294 inches; total evaporation for six months from April 17 to October 22, was 37.020 inches.

The highest barometer was on September 28, 23.388; the lowest on December 15, 22.543; mean barometer for the year, 23.049.

The prevailing direction of the wind was southwest. The greatest number of miles traveled in one month was 12.047, in March; the greatest number of miles in one day, 547, November 26.

Meteorological Notes, 1891-1896.

These notes are made from the records kept for the last five years at the various Experiment Farms.

LARAMIE.

The instruments are kept at the University. The farm is situated nearly three miles southwest, at about the same altitude.

The dome of the University is in latitude 41° 18′ 37.09″ North, and in longitude 105° 34′ 53.75″ West from Greenwich. It is 30.260 miles west of the 105th meridian. The longitude from Greenwich expressed in time is 7 hours, 2 minutes, 19.58 seconds. Difference in time between Greenwich and Washington is 5 hours, 8 minutes, 12.04 seconds. Difference between Washington and the University, 1 hour, 54 minutes and 7.54 seconds. The length of a degree of longitude in latitude 41° 19′ is 52.030 miles. The altitude of Laramie where Grand Avenue crosses the Union Pacific railroad is 7,149 feet above sea level.

The above accurate data was furnished by Hon. Wm. O. Owen, State Auditor, who was for many years County Surveyor of Albany County.

Two students of the University, L. E. Morris and Harry Houston, run check levels from the point mentioned on the Union Pacific railroad to the room in which the meteorological instruments are kept, and found it to be

38.75 feet above the railroad, making the true altitude of the room 7,187.75 feet.

Temperature.

For the last six months of 1891 the highest temperature at Laramie was 82.5°, on August 13; the warmest day for twenty-four hours was on August 5, mean, 67.4°. In 1892 the highest temperature was 86°, on August 14 and 16; the warmest day for twenty-fours was on July 20; mean, 71.2. In 1893 the highest temperature, 87.2°, occurred on July 21. In 1894 the highest temperature was 87.6°, on July 11; the warmest day for twenty-four hours was 71.5°, on July 11. In 1895 the highest temperature was 87°, on July 27; the warmest day for twenty-four hours was 68.6°, on July 27.

The lowest temperature at Laramie for the last six months of 1891 was —13°, on December 7. The coldest day for twenty-four hours was 3.7°, on December 25. In 1892 the lowest temperature was —29°, on January 11; the coldest day for twenty-four hours was also on January 11, —13.5°. In 1893 the lowest temperature was —9.2°, on February 27. In 1894 the lowest temperature was —27°, on December 28; the coldest day for twenty-four hours was —10.5°, on December 27. In 1895 the lowest temperature was —29.5°, on February 12; the coldest day for twenty-four hours was —21.5°, on February 12.

The mean annual temperature for 1891 was 40.9°; for 1892, 40.5°; for 1893, 40.6°; for 1894, 39.9°; for 1895, 38.5°. The average for five years was 40.08°.

The greatest daily range of temperature for Laramie in 1891, from July to December, was 50°, on August 7; in 1892 it was 44°, on October 3; in 1893 it was 49°,

on January 24; in 1894 it was 49°, on January 24; in 1895 it was 45.5°, on February 16.

The lowest daily range from July to December in 1891 was 4.2°, on December 28; the mean daily range for the same time was 26.4°. In 1892 the lowest was 1.3°, on December 16; the mean daily range for the year was 23.9°. In 1893 it was 0.5°, on March 20. In 1894 it was 0.5°, on March 20. In 1895 it was 0.5°, on May 30.

By studying the range of temperature of any particular region we can form a good idea of its climatic condition. Observe above that there is sometimes as much as 50° difference between night and day; for example, on August 7, 1891. The average daily range for August, 1892, was 32°, showing that we have warm days and quite cool nights, which condition prevailing throughout the year brings down the average temperature to about 40° F.

The average maximum temperature for August, 1892, was 77.9°.

The average minimum temperature for the same time was 45.7°

The mean relative humidity from July to December, 1891, was 66.4; for 1892 it was 63.7; for 1893 it was 56.9; for 1894 it was 56.4; for 1896 it was 58.5.

The lowest relative humidity for 1892 was 13.3, on November 14; for 1893 it was 9.2, on January 8; for 1894 it was 10.6, on June 26; for 1895 it was 15.7, on April 25.

The mean dew-point for the last six months of 1891 was 30.1°; for 1892 it was 24.6°; for 1893 it was 21.7°; for 1894 it was 22.5°; for 1895 it was 23°.

The highest dew-point for 1892 was 55.5°, on June 22; for 1893 it was 54.5°, on July 26; for 1894 it was 56.2°, on July 3; for 1895 it was 54.5°, on July 30.

The lowest dew-point for 1892 was —21°, on January 11; for 1893 it was —16°, on December 16; for 1894 it was —23°, on December 28; for 1895 it was —15°, on December 29.

Evaporation.

The evaporation from July 22 to November 11, 1891, was 22.7 inches; in 1892, from May 24 to October 10, it was 34.91 inches; in 1893, from May to October, it was 37.525 inches; in 1894, from April 26 to October 27, it was 37.166 inces; in 1895, from April 17 to October 22, it was 37.020 inches.

The greatest monthly evaporation for the last six months of 1891 was 8.59 inches for August; in 1892 it it was 9.19 inches for July; in 1893 it was 9.35 inches for July; in 1894 it was 7.492 inches for June; in 1895 it was 7.334 inches for May; July was next, nearly the same, 7.294.

Barometric Height.

The mean barometer for the last four months of 1891 was 22.969; for 1892 it was 23.041; for 1893 it was 23.196 (the record was not complete); for 1894 it was 23.054; for 1895 it was 23.049.

The highest barometer for 1892 was 23.382 inches on October 26; for 1893 it was 23.418 on September 1; for 1894 it was 23.389 on July 1; for 1895 it was 23.387 on September 28.

Lowest barometer for 1892, April 3, 22.466 inches; for 1893, January 31, 22.501 inches: in 1894, on January

3, 22.531 inches; in 1895, December 15, 22.543 inches. Average for past four years, 23.075 inches.

Terrestrial Radiation.

Mean terrestrial radiation for the last six months of 1891 was 2.9°; for the whole year of 1892 it was 3.2°; for the year 1893 it was 3.5°; for 1894 it was 4.4°; for 1895 it was 4.07°.

The highest terrestrial radiation for 1892 was 9.1° on December 22; for 1893 it was 11° on September 8; for 1894 it was 11° on September 27; in 1895 it was 15.5° on November 27.

Wind.

The greatest number of miles traveled by the wind in one month for each of the last four years was as follows: For 1892, in April, 12,918.3; for 1893, in March, 12,500 miles; for 1894, in March, 12,265 miles; for 1895, in March, 12,047 miles. The average for March for the past four years, 12,432 miles.

The greatest number of miles traveled in one day in 1892 was on January 4, 980.1 miles; in 1893, March 12, 713 miles; in 1894, June 5, 918 miles; in 1895, November 26, 547 miles.

The greatest velocity per hour for the last six months of 1891 was on November 10, 65 miles per hour; for the the year 1892 it was in March, 87.2 miles per hour; for 1893, May 25, 68 miles per hour; for 1894, 56 miles per hour, on April 15, also on June 6; for 1895 it was 54 miles, on September 21.

Precipitation.

The highest monthly precipitation for the year 1891 was 2.92 inches in May; in 1892, 3.97 inches in June;

for 1893 it was 0.54 inches, in June; for 1894 it was 1.60 inches, in June; for 1895 it was 2.71 inches in July.

The greatest percipitation for one single storm in 1892 was 3.90 inches melted snow, October 11 and 12. There was also a heavy snow storm June 4 and 5, 1892, giving 3.31 inches melted snow. In 1893, June 4, 0.47 inches. In 1894, April 18, 1 inch melted snow. In 1895, May 31, 0.98 inches.

The annual precipitation for 1891 was 13.92 inches; for 1892 it was 12.73 inches; In 1893 it was 3.84 inches; for 1894 it was 8.63 inches; in 1895 it was 11.15 inches.

The average annual precipitation for the last five years was 9.85 inches. This low average was due to the very small rain fall of 1893, the amount being 3.84 inches, the smallest on record for this region. During the year 1894 it was also very small, viz., 7.63 inches. The average percipitation from the records, three miles south, at Fort Sanders, for nine years from 1869 to 1878, was 12.92 inches. The average for 1891, 1892 and 1895 is 12.60 inches.

Soil Temperatures.

The following are the mean soil temperatures for the past four years and a half: July 5, 1891, to January 2, 1892, three inches, 44.6°; six inches, 48.5°; twelve inches, 49.8°; twenty-four inches, 50.4°; thirty-six inches, 48.6°; seventy-two inches, 51.7°.

In 1892 the air temperature near the ground was 38.4°; three inches in the ground, 42.7°; six inches 44.5°; twelve inches, 44.9°; twenty-four inches, 44.7°; thirty-six inches, 46.1°; seventy-two inches, 45.7°.

In 1893, air, 40.8°; three inches, 43.1°: six inches,

45.3°; twelve inches, 45.1°; twenty-four inches, 44.8°; thirty-six inches, 45.0°; seventy-two inches, 45.3°.

In 1894, air, 39.1°; three inches, 44.5°; six inches, 45.8°; twelve inches, 45.8°; twentw-four inches 45.5°; thirty-six inches, 45.5°; seventy-two inches, 45.7°.

In 1895, air, 37.9°; three inches, 43.7°; six inches, 44.4°; twelve inches, 44.2°; twenty-four inches, 44.5°; thirty-six inches, 44.5°; seventy-two inches, 45.0°.

The greatest difference between the three-inch thermometer for four years was 1.8°; for the six-inch was 1.4°; the twelve-inch, 1.6°; the twenty-four-inch 1°; the thirty-six-inch, 1.6°; the seventy-two-inch, only 0.7°

Frosts.

In 1891 there was a light frost July 13. An injuring frost on August 22. In 1892 light frosts June 5, 6, 7 and 13. Killing frost August 29. In 1893, killing frosts June 6 and August 16. In 1894 light frost May 24 and 25. In 1895, on June 18, killing frost.

LANDER.

The Lander farm is situated in latitude about 42° 50′ North and 108° 45′ West longitude. Altitude, 5,500 feet.

The records have been kept and faithfully reported from the beginning by J. S. Meyer, superintendent of the farm.

This section is protected by surrounding hills and

mountains, and the climate is quite favorable for agriculture under irrigation.

General Summary for the Past Five Years.

The highest temperature for last six months of 1891 was in August and September, 87°. The mean temperature for July was 63.5°; August, 66.1°, and September, 58.4°. In 1892 the highest was 92°, in August; the warmest day for 24 hours was 79°, August 15. In 1893 it was 94° on July 19; the warmest day for 24 hours was 78.5°, on July 18. In 1894, July 10, it was 94°; the warmest day for 24 hours was 71°, on July 9 and 10. In 1895, July 26, it was 89°; the warmest day for 24 hours was 84°, July 26.

The lowest temperature for the last six months of 1891 was —19° in December. In 1892 the coldest was —26°, on Jannary 11; the coldest for 24 hours was —8° on the same day, January 11. In 1893, February 14 was the coldest, —10° below; the coldest for 24 hours was 6°, February 14. In 1894, February 20, it was —24°; the coldest day for 24 hours was —5°, January 23. In 1895 February 11 was the coldest, —26°; the coldest day for 24 hours was —10, February 11.

The mean annual temperature for the last four and one-half years was as follows: The last six months of 1891 the average was 49.3°; the average for 1892 was 44.8°; for 1893 it was 44.3°; for 1894 it was 43.4°; in 1895 it was 42.1°; general average, 43.7°.

The greatest daily range of temperature for the last six months of 1891 was 50°, on December 8; for 1892 it was 57°, on December 22; for 1893 it was 45°, on January 26; in 1894 it was 48°, on September 16; in 1895 it was 49°, on September 16.

The mean daily range for 1892 was 27.5°; for 1893 it was 24.7°; for 1894 it was 27.8°; for 1895 it was 26.2°; the average for four years was 26.55°.

Lowest relative humidity for 1892 was 12.8, on June 8th.

The highest dew-point for 1892 was 62.1°, August 9. Lowest dew-point, —12°, November 7.

Precipitation.

The precipitation for the last six months of 1891 was 4.23 inches. Total for 1892 was 11.94 inches. The greatest monthly precipitation was in April, 4.89 inches. The greatest precipitation during one single storm for 1892 was 1.91 inches, July 7. The total precipitation for 1893 was 11.62 inches; for 1894 it was 10.72 inches; for 1895 it was 19.66 inches. The average for the past four years was 13.49 inches.

Frosts.

There were rather heavy frosts on June 4 and 13, 1892, a light frost on August 28 and killing frosts on October 12 and 14. In 1893 there were killing frosts on May 24, 25, 26 and 27, and September 22 and 23. In 1895, killing frosts June 17 and 18, and September 7, 21, 22, 23, 24 and 29.

SARATOGA.

Saratoga is situated in latitude about 41° 28′ and longitude 107° 5′. Altitude about 6,800 feet. Being located in a broad valley, and so near the same latitude and altitude as Laramie, the climatic conditions are quite similar.

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The records were kept by the Superintendent of the farm, J. D. Parker, from the beginning of the work in 1891 until June, 1895, the experiments having then stopped on the farm on account of the lack of water.

General Summary for Four Years.

The highest temperature for the last six months of 1891 was 93°, on August 12. July and August had the highest mean, each 66.6°. In 1892 the highest was 92° on August 2 and 3; the warmest day for twenty-four hours was on July 24, viz., 72.5°. In 1893 the highest temperature was on July 21, 89°; the warmest day for twenty-four hours was 70.5°, on July 9. In 1894 the highest temperature was 88°, on July 10; the warmest day for twenty-four hours was 72.5°, on July 10.

The lowest temperature for the last six months of 1891 was —15°, on December 25. For 1892 it was —26°, on December 16 and 17; the coldest day for twenty-four hours was —6°, on December 17. The lowest temperature for 1893 was —13°, on February 13; the coldest for twenty-four hours was 5°, on February 13. The lowest temperature for 1894 was —29°, on December 27; the coldest for twenty-four hours was —10°, on December 27.

The following is the average temperature for each of the last four years: The last six months of 1891 the average was 45.4°; the average for 1892 was 41.6°; for 1893, it was 39.3°; for 1894 it was 40.3°. The general average for 1892, 1893 and 1894 was 40.4°.

The greatest daily range for the last six months of 1891 was 56°, on October 18; for 1892 it was 53°, on

June 1; for 1893 it was 46°, on June 19; for 1894 it was 66°, on November 15.

The lowest daily range for 1891 (six months) was 5° on December 2: for 1892 it was 2°, on January 13; for 1893 it was 5°, on April 25; for 1894 it was 3°, on December 24.

The mean daily range for 1892 was 29°; for 1893 it was 27.1°; in 1894 it was 29°. The mean daily range for 1892, 1893 and 1894 was 28.4°.

Precipitation.

The precipitation for the last six months of 1891 was 4.65 inches; the total for 1892 was 8.91 inches; for 1893 it was 14.52 inches; for 1894 it was 12.73 inches. The average for 1892, 1893 and 1894 was 12.05 inches.

The greatest precipitation for one single storm in 1892 was 1.61 inches on October 11 and 12; in 1893, 1.01 inches on June 2; in 1894, 1.11 inches on March 19. In 1895, March 29 and 30, the heaviest snow-storm for years, 24 inches. Observations stopped in June, 1895.

SHERIDAN.

Sheridan is situated in about 44° 48′ latitude, and 106° 57′ longitude. Altitude, 3,750 feet. It is the most northern part of the State from which we have reports of the weather.

The observations were reported by James A. Becker up to 1893; since then by John F. Lewis, Superintendent of the Experiment Farm.

The comparatively low altitude compensates in a great measure for the latitude. It is subject to greater extremes of heat and cold than any of the other farms. It is but a few miles from the Montana line. The growing season is comparatively long, and the agricultural possibilities very good.

A General Summary for the Last Four Years and a Half.

The warmest temperature observed for the last six months of 1891 was 90°, in August. The mean temperature for August was 65.3°. In 1892 the highest temperature was 89°, on August 24 and 31; the warmest day for twenty-four hours was 80.5°, on August 14. In 1893 the highest temperature was 102°, on July 20; the warmest day for twenty-four hours was 81.5°, on July 23. In 1894 the highest temperature was 96°, on August 27; the warmest day for twenty-four hours was 75°, on July 30. In 1895 the highest temperature was 94°, on July 2, 24 and 27; the warmest day for twenty-four hours was 72.5°, on August 2 and 13.

The lowest temperature for the last six months of 1891 was —24°, on November 16. For 1892 it was —46°, on January 11; the coldest for twenty-four hours was —22.5°, on January 11. For 1893 the lowest temperature was —45°, on February 1; the coldest for twenty-four hours was —27.5°, on January 31. For 1894 the lowest temperature was —36°, on January 24; the coldest for twenty-four hours was —19.5°, on January 23. For 1895 the lowest temperature was —38°, on February 7; the coldest for twenty-four hours was —17.5°, on February 7.

The following is a list of the mean temperatures for

the last four years, some of the records for the last six months of 1891 having been lost: The average for 1892 was 41.3°; for 1893 it was 41.7°; for 1894 it was 42.8°; for 1895 it was 41.3°. The mean of the annual temperatures for the last four years was 41.5°.

The record showing the greatest daily range for the last six months of 1891 is not complete. For 1892 it was 55°, on October 4; for 1893 it was 55°, on October 21; for 1894 it was 62°, on October 16; for 1895 it was 67° on January 4.

The lowest daily range for 1892 was 1°, on November 24; for 1893, 0°, on April 29 and November 17; for 1894 it was 3°, on March 3 and 20 and November 18; for 1895 it was 2°, on June 2.

The mean daily range for 1892 was 28°; for 1893 it was 28.5°; for 1894 it was 30°; for 1895 it was 29.4°. The average for the four years was 28.97°.

Precipitation.

The precipitation for the last six months of 1891 was 5.04 inches; for 1892 it was 16.26 inches; for 1893 it was 12.60 inches; for 1894 it was 12.49 inches; for 1895 it was 15.64 inches.

The greatest monthly precipitation for 1892 was 3.29 inches in June; for 1893 it was 3.40 inches in May; for 1894 it was 3.15 inches in March; for 1895 it was 2.25 inches in April.

The greatest precipitation during one single storm in 1892 was 1.56 inches, October 11; in 1893 it was 1.76 inches, May 20; in 1894 it was 0.53 inches on April 7; in 1895 it was 0.95 inches on June 1.

Frosts.

Light frosts occurred in 1892 on May 13, 20 and 21; killing frosts May 2 to 6, and September 11.

In 1893, killing frosts May 27 and September 23.

In 1894, hail and snow on April 18.

In 1895, September 19 and 20, heavy snow; ice two inches thick; August 30, hail did some damage; several light frosts in June; killing frosts May 11, 16 and 29.

SUNDANCE.

Sundance is situated in latitude about 44° 24′ and longitude 104° 22′. Altitude about 4,750 feet.

The observations were reported at first, up to 1894, by Thomas A. Dunn, superintendent of the farm, but since then by the present superintendent, A. E. Hoyt.

The comparatively low altitude and the protection from mountains, together with the highest annual precipitation in the State, render the climate mild and the season of growth long.

It is the only farm of the Experiment Station where crops, generally, are matured without irrigation.

Notice further on the comparatively high precipitation for the past four years.

General Summary for the Past Four Years.

The highest temperature for the last six months of 1891 was 96°, on August 6; the mean for August was 63.5. In 1892 the highest temperature was 98°, on August 15; the warmest day for twenty-four hours was

77.8°, on August 12. In 1893 the highest temperature was 96°, on July 22 and August 6; the warmest day for twenty-four hours was 79°, on July 11 and 22. In 1894 the highest temperature was 94°, on July 30; the warmest day for twenty-four hours was 79.5°, on August 21. In 1895 the highest temperature was 94°, on July 12; the warmest day for twenty-four hours was 77°, on August 4.

The lowest temperature for the last six months of 1891 was —10.5°, on November 16. In 1892 the lowest temperature was —26°, on January 18; the coldest day for twenty-four hours was —15°, on January 10. In 1893 the lowest temperature was —31.5°, on January 31; the coldest day for twenty-four hours was —14°, on February 7. In 1894 the lowest temperature was —28°, on January 23; the coldest day for twenty-four hours was —23.5°, on January 23. In 1895 the lowest temperature was —31°, on February 7; the coldest day for twenty-four hours was —10.5, on February 7.

The average temperature for 1892 was 41.2°; for 1893 it was 40.6°; for 1894 it was 42.3°; for 1895 it was 40.7°. The general average for the four years was 41.2°.

The greatest daily range for the last six months of 1891 cannot be determined, as the instrument was broken. For 1892 it was 46°, on September 26; for 1893 it was 49°, on February 4; for 1894 it was 49°, on March 28; for 1895 it was 45°, on April 16 and July 24.

The lowest daily range for the last six months of 1891 (instrument broken); for 1892 it was 2°, on May 2; for 1893 it was 2°, on February 5, April 24 and May 24;

for 1894 it was 2°, on December 7; for 1895 it was 3°, on November 5.

The mean daily range for 1892 was 22.8°; for 1893 it was 24.9°; for 1894 it was 23.9°; for 1895 it was 23.1°.

Precipitation.

The precipitation for the last six months of 1891 was 11.70 inches; in 1892 it was 24.69 inches; in 1893 it was 16.56 inches; in 1894 it was 19.99 inches; in 1895 it was 23.84 inches. The general average for the past four years was 21.27 inches.

The greatest precipitation for one single storm for 1892 was 1.3 inches on January 31; for 1893 it was 4 inches melted snow on January 14; for 1894 it was 1.62 inches on May 16; for 1895 it was 2.01 inches on June 4

Frosts.

In 1892 light frost on June 5; killing frost September 11. In 1893, killing frosts May 22 and September 23. In 1894, light frosts every night in October. April 16, 1894, first hail of season.

WHEATLAND.

Wheatland is situated in about 42° latitude, and longitude 104° 54′ West. Its altitude is 4,700 feet, and being on the undulating plateau which extends from the Laramie range of mountains along the North Platte river into Nebraska, it is subject at times to the hot, dry winds of the plains, but they are not destructive. The season of

growth is long, warm and favorable to crops, while the winters are not severe.

Most of the above description is taken from the Meteorological Bulletin of 1892. It is quite necessary to append the following note given in that Bulletin:

"The thermometers at Wheatland are not kept in a regular instrument house of the weather service, as at the other stations, but are located in a sheltered position, which would probably give little difference in temperature. However, this fact should be borne in mind in considering the above highest temperature, as it may be excessive."

The observations are reported by M. R. Johnston, superintendent of the Experiment Farm.

General Summary for the Last Four Years.

The highest temperature for the last six months of 1891 was 96°, on August 4; the warmest day for twenty-four hours was 78°, on August 6; the mean for August was 65.7°. In 1892 the highest temperature was 109°, on July 21; the warmest day for twenty-four hours was 88.5°, on July 21. For 1893 the highest temperature was 108°, on June 18; the warmest day for twenty-four hours was 84.5°, on July 12; it was 84° on June 18. For 1894 the highest temperature was 99°, on July 11; the warmest day for twenty-four hours was 81.5°, on July 10. For 1895 (the last eight months) the highest temperature was 101°, on July 27; the warmest day for twenty-four hours was 81.5° on August 11.

The lowest temperature for the last six months of 1891 was 0°, on November 17 and December 25; in

1892 it was —21°, on January 11; in 1893 it was —16° on January 28; in 1894 it was —22°, on January 26.

The coldest day for twenty-four hours in each year was as follows: In 1892, —12°, January 18; 1893, 6°, on November 30; 1894, 0°, on February 19; 1895 (for last eight months), 13.5°, on December 29.

The mean annual temperatures for the last four years were as follows: For the last six months of 1891 it was 48.35°; for 1892 it was 49.2°; for 1893 it was 48.8°; for 1894, (instruments broken late in 1894, which interfered with a complete record for 1894 and 1895.)

The greatest monthly range for the last six months of 1991 was 49°, on November 4; for 1892 it was 57°, on March 17; for 1893 it was 55°, on March 30; for 1894 it was 52°, on September 24; for 1895 (last eight months) it was 52°, on November 22.

The lowest daily range for the last six months of 1891 was 5°, on September 8 and December 30; for 1892 it was 1°, on January 16; for 1893 it was 0°, on April 17; for 1894 it was 1°, on April 30; for 1895 it was 7°, on December 10.

The mean daily range for 1892 was 29.4°; for 1893 it was 30.9; for 1894 (November and December missing) it was 29.9°; for 1895, record not complete.

Precipitation.

The precipitation for the last six months of 1891 was 5.54 inches; total for 1892 was 14.51 inches; for 1893 it was 6.42 inches; for 1894 it was 10.13 inches; for 1895 (for eight months, commencing with May) it was 13.06 inches.

The average for the three years, 1892, 1893 and 1894, was 10.35 inches.

The greatest precipitation during one single storm for 1892 was 1.30 inches on May 13; for 1893 it was 0.6 inches on October 11, and six inches snow on December 24, which is equivalent; for 1894 it was 1.25 inches on June 15 and July 3. For 1895 (eight months, commencing with May) it was 1.5 inches on June 2.

Frosts.

Light frosts in 1892 on June 6 and October 5; killing frost October 22. In 1893, light frost May 19 and killing frosts on September 23, 24 and 25. In 1894, light frost May 3.

Notes.

The remarkable growth of cereals and all root-crops, by irrigation, at all the experiment farms, and at Sundance without irrigation, illustrates the adaptation of the climate to the growth of most of the farm products grown in northern states.

The farms can be grouped into pairs, and it is interesting to observe the parallelism between them. Laramie and Saratoga can be grouped together as the most southern points in an east and west line, they being about the same latitude and altitude ; consequently they are very similar in temperature and nearly the same in amount of precipitation, and in agricultural productions. Lander and Wheatland can be grouped on the same principle, as representing a line east and west across the middle of the state, Lander being very near the center, and Wheatland about 200 miles to the east. Their altitude as well as their agricultural possibilities are very nearly the same. Sheridan and Sundance are in an east and west line in the extreme northern part of the state, and in altitude are lower than either of the others. They have greater extremes of heat and cold than the other points, although their annual temperature is a little higher than that of Laramie and Saratoga, which are 250 miles further south ; but the temperature at Laramie and Saratoga is more uniform, on account of their more favorable latitude and higher altitude. They do not have the extremes of summer and winter as at the other farms.

To illustrate, let us take the extreme northern and southern farms, viz., the ones at Sheridan and at Laramie. The highest temperatures at Sheridan for the last four years were 89°, 102°, 96° and 94°. At Laramie for the same time, 86°, 87.2°, 87.6° and 87°. The coldest days at Sheridan for the same years were —46°, —45°, —36° and —38°; at Laramie for the same time, —29°, —9.2°, —27° and —29.5°. The annual temperature at Sheridan for the four years was as follows, viz, 41.3°, 40.6°, 42.8° and 40.7°; and at Laramie it was 40.5°, 40.6°, 39.9° and 38.5°. The average daily range at Sheridan for four years has been 29°; at Laramie 24.8°.

July has averaged the warmest at all the farms, and August has ranked second. The averages for June and September have been nearly the same. February has averaged the coldest at all the points; January ranked second and December third; but in 1892 January was the coldest December ranked second and February third. In 1893 February was the coldest December ranked second and January third. In 1894 February was the coldest January ranked second and December third. In 1895 February was the coldest January ranked second and December third.

The mean for each month at Laramie for the last four years was as follows, viz: January, 22°; February, 20°; March, 29°; April, 37.2°; May, 46.6°; June, 55.2°; July, 62.2°; August, 61.6°; September, 53.8°; October, 44.2°; November, 28°: December, 21°. When February has not been the coldest month the annual temperature has been comparatively warm.

The sunshine record has not been worked out for all

the farms; but we will quote enough from Bulletin Number 10, 1892, to give a fair idea of the percentage of sunshine prevailing in Wyoming, taking the center of the state, the southern and the extreme northern points.

The sunshine at Lander indicates 13.6 per cent cloudy days; nearly 25 per cent clear; the remaining 61.4 per cent were partially cloudy, termed fair. September was the sunniest month, having no cloudy days, while May was the cloudiest, having 11 cloudy days.

Saratoga observations indicate 16.5 per cent cloudy days, with April the cloudiest month; 38.3 per cent clear days, with September the sunniest month; the remailing 45.2 per cent are fair.

Sheridan observations on the character of the day indicate 21 per cent cloudy days, with May the cloudiest month; 51.4 per cent clear days, with September the sunniest month; the remaining 27.6 per cent being fair.

This is sufficient to show the very high percentage of sunshine in the State of Wyoming.

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First Report
... on the ...
Flora of Wyoming

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

BULLETIN NO. 28.

MAY, 1896.

First Report on the Flora of Wyoming

BY THE BOTANIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

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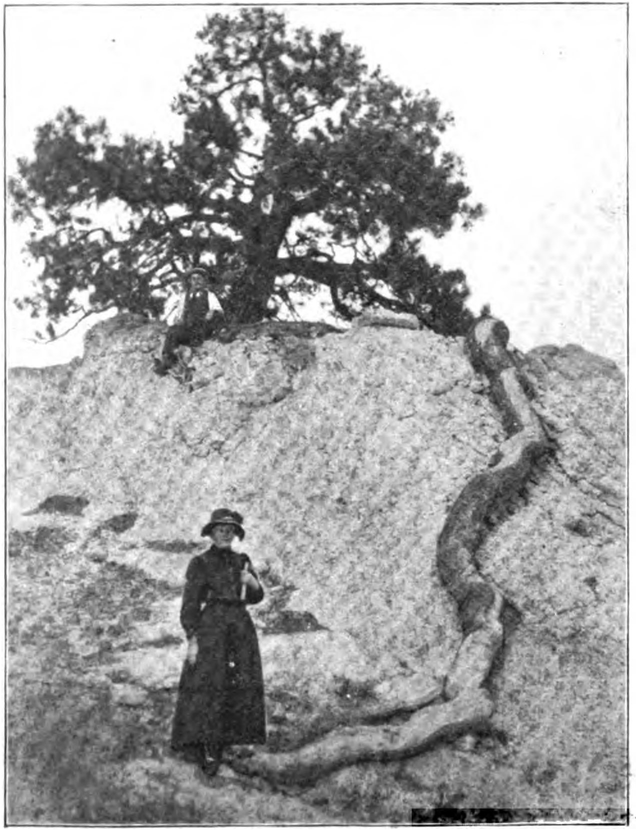
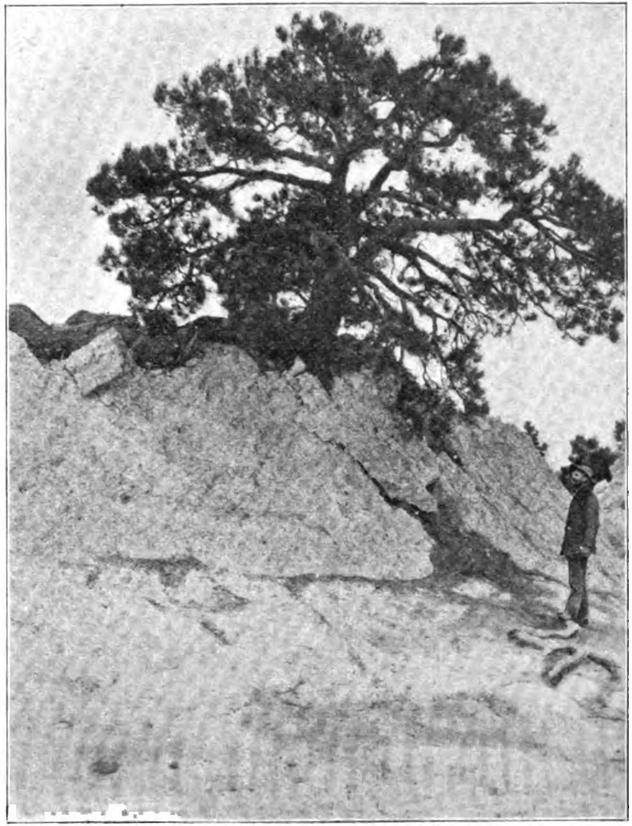
ERRATA.

Page 83 read Erysimum for Erisymum.
Page 99 read Glycyrrhiza for Glyceria.
Page 170 read Monolepis for Monolepsis.
Page 199 read Cryptogramme for Chryptogramma.
Page 142 line 5 from bottom read Triassic for Tertiary.





ROCKY MOUNTAIN YELLOW PINE.

Showing remarkable root development. Length from tree to point where root enters the ground, 45 feet. Sand Hills, 12 miles north of Lusk.

From Photograph by Prof. B. C. Buffum.

Univ. of Wyoming

FIRST REPORT

ON THE

FLORA OF WYOMING.

BY AVEN NELSON.

INTRODUCTION.

Among the duties planned by and for the Botanist of the Experiment Station for the year 1894 were the following:

1. To study the Fungi affecting the ordinary farm crops and the best means of combatting the same.

2. To give attention to the weed question, with a view to finding effective methods for exterminating or preventing the spread of the more troublesome ones.

3. The building up of the herbarium.

4. The preparation of a report upon the flora of the state.

These all received attention to the extent of the time that could be spared from other imperative duties, such as those of the classroom and the routine work of the Station, but it was found necessary to continue the same subjects for 1895. During that time one phase of the first has had attention in Bulletin No. 21, "The Smut of Grains and Potato Scab;" the second in Bulletin No. 19, "Squrrel-Tail Grass (Fox-Tail)," our worst weed, and a Press Bulletin on the "Russian Thistle." The third has, of course, gone on incidentally with and preparatory to the fourth.

Although what has been done in the study of the flora of the state has cost no little time and labor yet the work seems but barely begun. The preparation of a full and reasonably inclusive report on the flora of a great state of nearly 100,000 square miles would be the work of years for a corps of men devoting their full time to the matter in hand, so one man with a full slate of college teaching and other Experiment Station duties, besides that of working up the flora, would lose courage were it not for the absorbing interest of the subject itself. Since to delay the report until it should be approximately complete would project it far into the future and might possibly result in its never being published, it has seemed advisable to publish the results thus far attained. As the work goes on and results accumulate, other reports may, from time to time, appear to record the additions.

COLLECTING TRIPS.

The basis for the following brief report and the catalogue of species rests mainly upon the collections made by the writer in 1894 and in 1895.

With one exception, as given below, no systematic work in collecting had previously been done. In 1892, Prof. B. C. Buffum, at that time acting botanist of the Station, spent the mid-summer months in the field collecting—primarily to secure for the University and the Station a collection of the native grasses and forage plants, an exhibit of which was to be made at the World's Fair at Chicago in 1893. Incidently much more was done, for a considerable amount of good material, other than grasses, must be put down to the credit of the expedition.

From this material were obtained the numbers which formed the nucleus of the present collection in our her-

barium. Quite a large part of the state was covered during this trip, extending from Laramie, on the south, to Lander and the Wind River Mountains on the north-west, to Sheridan and the Big Horn Mountains on the north, and Sundance, Fort Laramie, and Wheatland on the east. How many numbers were collected, I am unable to state, as no field or collection numbers were made use of, but in the succeeding catalogue of plants those species where no collection number is noted, are generally to be credited to this expedition. In the Gramineæ and Cyperaceæ much the larger number of species are the result of this earlier expedition in which these groups received such thoroughgoing attention that in the later collecting trips it seemed advisable to concentrate attention upon the other Phanerogams.

It may be of interest to give briefly the history of the field work that furnished the material upon which this report rests.

1894.

During the continuance of the spring term of school, operations had to be confined to Laramie and adjacent territory. Mornings and evenings, holidays and Saturdays were used with all diligence. The most distant point reached was Table Mountain, about twenty miles to the east, and on the west the Laramie River served as boundary line. Limited as was the area covered and late as seasons are at this altitude, June 30 saw 300 numbers collected and stored in duplicate.

At the annual meeting of the Board of Trustees at the close of the school year, provision was made for an expedition to go into the field during the summer vacation, in the interest of the departments of geology and

botany. Preparations for setting out were perfected as rapidly as possible, but it was not until July 7 that the start was made.

Beside the writer

THE PARTY

consisted of W. C. Knight, Professor of Geology in the University and Geologist of the Station; Mr. W. H. Reed, who furnished a large part of the outfit for the expedition; Mr. Geo. M. Cordiner, a student at the University, who accompanied the party as the writer's assistant.*

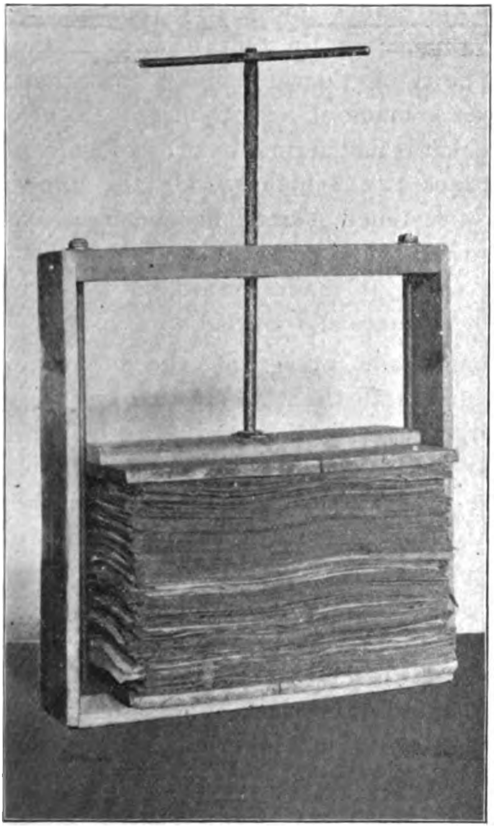
The expenses of the expedition were reduced to a minimum as they consisted of only the actual living expenses of the party in the field, plus the expense incident to securing the services of Mr. Reed, with his two teams and wagons and one saddle horse. The camp equipage consisted of all the necessary utensils, ample bedding, a tent, (which, owing to the perfect weather, was rarely used), a stock of groceries, besides the necessary apparatus for collecting in both botany and geology.

The botanist's outfit may be of interest and was as follows: Two ordinary-sized tin collecting cans, one of which had a number of small compartments at the end for diminutive and delicate objects, and one large tin vasculum—so large that it was always referred to as the "tin trunk." This was indispensable during the long mountain trips, when it was a desideratum to be able to bring back once for all a large amount of material. The most efficient instrument for uprooting plants, both on the plains and among the rocks in the mountains, was found

*It is with deep sorrow that I record the death of this noble young man. On March 14, 1895 he received fatal injuries during a fire in Laramie by being caught under the falling walls of a building from which he was helping to remove goods. While in the field he greatly endeared himself to the writer by his constant cheerfulness, his remarkable faithfulness to duty, his high efficiency and his moral worth.

to be a carpenter's strong chisel about three-fourths of an inch broad. Of course, a stout knife is not to be omitted from any collecting outfit.

Five plant presses were carried and found none too many at times, but at other times two would have been more than enough. Four of these were slat presses, the pressure in two being applied by straps and in the other two by cords as in the Acme press. The fifth, and most important one, was a screw-press and as it filled its purpose so admirably and proved so valuable an adjunct to the outfit, I add here a figure and brief description.



The base and the top bars are of oak, 2 x 4½ x 20 inches, the distance between them being 21 inches. They are united by one-half inch bolts so placed as to be eighteen inches apart. To

keep the base and top in place when the pressure is relaxed strips of board $\frac{1}{2}$x$4\frac{1}{2}$ inches are nailed to the ends. The floor to receive the package of plants is 12x18 inches, made by nailing pine board $\frac{7}{8}$ inches thick crosswise of the base. The screw is a $\frac{3}{4}$-inch bolt with 15 threads to the inch, about 15 inches thread bearing. A square nut is sunk on the under side of the top bar and held in position by a piece of tin tacked over it, the tin having a circular hole in it large enough to admit the bolt. The follower is made of a strip of pine 1x5x18 inches, crosswise on which is nailed pine board $\frac{7}{8}$ of an inch thick, making the surface 12x18 inches. On the upper face of the follower is fastened a small flat piece of iron with a sunk center to receive the end of the screw. The projecting end of the screw is made square, on which a removable handle with a square slot is used.

This homely, home-made press has the following advantages: It will furnish all the pressure that can possibly be desired; a large quantity of material can be handled at one time; coarse harsh plants can be forced into shape and held there; packages that have been in the screw press for twenty-four hours can be satisfactorily handled in the strap presses; moisture can be forced out so rapidly that by frequent change of driers the drying of the material may be considerably hastened; natural colors can be preserved in plants that by ordinary means would blacken; it furnishes a safe and convenient way for carrying the material while in press and in every way greatly facilitates the making of good flat specimens.

It was found that the capacity of this press is much greater than its dimensions would indicate. With a good quality of carpet felt for driers and single pressing sheets,

cut to size (newspaper quality, unprinted), it was possible to do good and rapid work. Experience shows that more plants are spoiled by too little than by too much pressure.

ROUTE AND PRINCIPAL CAMPS.

The accompanying map will indicate the route in a general way but of course cannot show the miles and miles of ground covered in the vicinity of the various camps, nor the wide detours made on horseback during the days the party was traveling. At a rough guess, more than two-thirds of the time was spent on the road, as the distance covered was upwards of 1,000 miles.

The days of travel were busy ones for the Botanist and his assistant, for at noon the collections of the morning were put into press, the driers on all the other recent material were changed, the damp driers thrown out on the hot sand and again collected. When camp was made for the night the afternoon collections were cared for, and, if they chanced to be heavy, the task was often completed by the campfire.

To enter into a detailed account of the journey would take up too much space, possibly to no purpose, so the following skeleton account must suffice: The route from Laramie took a north-east direction over the Laramie Hills past Grant, Wheatland and Uva postoffices to the Platte River, where camp was made July 10. After four days the camp was moved in turn to Hartville, a mining district, to Whalen Canon, and to the Mexican Mines. From this place a side trip was made by the Botanist and his assistant to Lusk. Camp was broken at the Mexican Mines on July 22, and the Platte River again reached at Orin Junction. From this place the river was followed

to Bessemer, passing in turn Douglas, Glenrock and Casper. From Bessemer, Poison Spider Creek was followed to its head near Garfield Peak in the Rattlesnake Mountains. Camp for a day was made on Wallace Creek at the foot of the peak. Up to that date, July 29, this was the richest collecting ground so far encountered. The road from there to the Big Popo Agie river lay across a barren desert, whose few streams were dry and the occasional springs mere mud holes, strongly impregnated with alkali.

The evening of July 30, caught us at Alkali Springs, a bog so densely impregnated with salt that only the almost famished horses could swallow a mouthful, and to one or two of the animals the draught came near proving fatal. There was no grass except an occasional stalk of salt-marsh grass–*Distichlis maritima* and *Triglochin maritima.* Thirsty as every member of the party was, after an all day's drive on the burning plain, not even coffee made from such water could be swallowed. Just at sunset a diminutive shower fell, and a dusty wagon sheet was called into service to catch the precious drops. As the little pool formed in the sagging center of the canvas what delicious draughts of nectar, thickened with the dust of many days, were dipped up with the old tin cups.

At four o'clock next morning, breakfastless, the party started for Beaver Creek, twelve miles distant. Breakfasting here where water was good and abundant, even the weakened horses were somewhat revived, though feed was still very scarce. Early in the afternoon the Big Popo Agie was reached by hard effort, and here three days were spent in camp to allow the sick and famished horses to recuperate. Water and grass

were both abundant, and the horses soon showed the effect of better treatment.

August 3, the camp was moved to Lander, where a stop of twenty-four hours was made, after which the expedition proceeded to and up the Big Wind River. The route lay across the Shoshone Indian Reservation, one camp being made at Fort Washakie. It was found necessary to ford the Big Wind River thirteen times before Dubois postoffice was reached. This is the last outpost of civilization on the river and it is near this place that the trail over the Wind River Mountains through Union Pass leads off from the river.

The ascent through the pass was begun on August 10, the summit of the range being reached early on the 11th. A most varied and beautiful vegetation was present on every hand all the way up, and at the highest point in the pass, about 9,500 feet, the open parks among the Spruce groves were covered with the wildest profusion of flowers—a veritable botanist's paradise. Two full days were spent here, but that was far too short a time even though the days were considerably lengthened out by the cheerful evening and early morning campfires. Union Peak, with its snow banks, the moist, dense copses on its slopes and the small fertile valleys at its base rivalled each other in the richness of their treasures.

The days were slipping by and the stay could not be prolonged even here, so on the 14th we turned our faces toward the three Teton peaks, whose lofty summits, though yet a hundred miles away, were seen from our present point of vantage standing out against the pellucid sky like mighty spires, their seamed and snow-flecked faces shining with a radiance possible only in such an

atmosphere as this. Over trails all but impassable, up hill and down dale, most laboriously we advanced and at last, on the 18th, camp was made in a Cottonwood grove on the banks of the Snake River in Jackson's Hole, near the foot of the Grand Teton.

Here some days were spent, during which an ascent of the Grand Teton was made. On the 20th three of us began the ascent. That night was spent on the shore of a small lake at about 9,500 feet. The next morning the more precipitous slopes were scaled, but at about 11,000 feet further progress was stopped by a frightful chasm which entirely cut off all communication with the spire-like summit that still towered above us. The descent was made more rapidly, and at nightfall on the 21st we were again in camp, loaded down with the collections of that and the preceding day.

This camp marked the most distant point reached by the expedition and on the afternoon of the 22nd the return journey was begun. The route lay up the Gros Ventre River, up Bacon Creek and over the divide separating it from Green River. On reaching Green River we camped for twenty-four hours, after which we proceeded to Cora postoffice on New Fork. At this point the route took a general south-east course, skirting the foot hills on the west of the Wind River range. The following streams were crossed in succession, viz: New Fork, Boulder Creek, East Fork, Silver, Willow, and Muddy Creeks, the Big and the Little Sandy. This brought us to South Pass City, the oldest mining camp in the Wind River Mountains, thirty miles south of Lander.

At this point, on September 1, the writer found it necessary to sever his connection with the expedition and

return to Laramie. Mr. Cordiner remained with the party, and, although it was becoming late in the collecting season and the route lay through a rather barren region, made doubly so by the large flocks of sheep that had been driven over the range, yet a number of interesting species were secured, but unfortunately, most of this material was lost by the burning of a car in the Laramie yards the night of its arrival.

The writer was in the field eight weeks and two days and the other members of the party ten weeks and three days. During this extended trip 900 numbers were made (including some that were secured after the return to Laramie), which, added to the 300 collected during the spring, made 1,200 numbers for the season of 1894. These were all collected in duplicate, ten or more sheets of each number being prepared whenever the material could be procured. This omniverous collecting resulted in quite a percentage of duplicates, so that the actual number of species, not counting forms, was probably not much above 1,000.

1895.

In 1895 it was not found possible to spend even the whole of the vacation in the field but all available time was utilized during the entire season. Especial effort was directed toward procuring such species as were not secured in 1894, and it seemed wise to concentrate effort upon a much more limited area. To this end four expeditions were planned and carried out.

The first one left Laramie June 27, going to the east and working Pole Creek, Table Mountain and adjacent territory, 103 species being secured. The second left Laramie July 25, camp being established at Cummins

City, from which point the surrounding mountains and valleys were scoured and resulted in 123 numbers. The third expedition left for Laramie Peak, seventy-five miles distant, on August 3 and returned with 117 numbers. The fourth made two camps, one in the Centennial Valley and one at the La Plata Mines near the summit of the Medicine Bow (Snowy) range. From these two points adjacent territory was worked and yielded 192 species, many of them quite rare.

Besides the above species, there were collected at various times during the season 135 numbers, making a total for 1895 of 670 numbers. As these were all in duplicate, approximately in tens, the total number was near 6,700.

Of the 670 species about one-half are new as compared with the collections of 1894.

PLANT ZONES.

Recent writers have made much of plant zones as limited by given lines of elevation. There is, no doubt, considerable truth in the theory that fairly well marked belts are found, but I think it is possible to overestimate the importance as well as the distinctiveness of such zones. There are so many other factors that enter into the problem, such as moisture, soil and exposure that its solution becomes peculiarly difficult. The zones sink and rise in conformity as much with the configuration of the land, the absence or presence of arboreal vegetation, the character of the soil and the amount of moisture as in respect to the altitude. The monotony of the grassy plain gives place to a veritable garden if but a few clay hummocks or stony points and ravines interrupt its interminable length. Seven thousand feet with one ex-

posure may produce a more truly Alpine flora than 9,000 feet with another.

Many species hold their own at almost all altitudes, and beginning with the lower altitudes, are successively in blossom throughout the season at higher and higher elevations. On the other hand, in given areas, a few certain plants are never met with except within a given range of elevation, but this given elevation differs for different parts of even the same state. It seems to be a a relative point depending as much upon the elevation of the surrounding country as upon the actual elevation above sea-level. It follows, therefore, that plant zones can only be established for a given area, as for instance, the Laramie Plains and the mountains that rise on either hand of it.

It has been well pointed out by Dr. Coville in his report on the "Botany of the Death Valley Expedition" that only certain plants can be taken to mark zonal lines. That only a few comply with the two characteristics of a good zonal plant, viz: "It shall have a definite termination at the borders of a zone or at lines substantially parallel thereto, but closer together." "That the belt of a zonal plant should be continuous." In any region I think this may be found true of a very small number of plants, but the large majority which have to be fitted into these zones will so overlap from zone to zone that no sharp distinctions can be drawn. Of course, between the lowest and the highest zone of a given area the characteristics are quite distinctive. These represent essentially different floras with as little in common as the vegetation of the plains and that of the adjacent mountains.

In this report it has not seemed wise to try to estab-

lish the vertical zones on account of the comparatively limited observations yet made within the wide borders of a great state. Rather something may be said of certain areas or characteristic regions.

THE PLAINS FLORA.

The regions referred to as plains differ greatly in respect to soil, rainfall and altitude. All are comparatively level tracts of land devoid of arboreal vegetation, if one excepts the occasional border of Cottonwoods on stream banks. In this report no mention can be made of the plains of the north-eastern, nor of the south-western parts of the state, for these regions are yet to be visited. It is, however, well known that both these regions differ materially from the rest of the state and from each other. The former, with a considerable rainfall and "gumbo" soil; the latter, sandy soil and a minimum of rain. Careful exploration in these two regions will add a large number of species to the list of the state.

The plains from which we have reports, meagre as yet, are the Laramie Plains; the plains lying east of the Laramie Mountains, and south of Lusk; those bordering on the Platte River, and those northward from the Platte through the center of the state to Lander; the plains adjacent to Wind River, and those of the upper part of the Green River valley; also the Gros Ventre valley, and Jackson's Hole. Through this latter mountain-enclosed, plateau-like plain flows Snake River.

All of these may again be classified, either as a whole or in part as: 1. Sandy, or gravelly plains. 2. Alkali plains.

To the first class belong those whose soil is comparatively free from alkali and whose characteristic shrub,

when any is present, is the common sage brush (*Artemisia tridentata*). The characteristic undershrub is some form of *Bigelovia*, indiscriminately called White Sage, Rabbit Brush, Golden Rod, etc. Plains of this character may also be denominated grassy plains. The grasses on these of course vary greatly as to the species and the luxuriance of their growth. The following are among those of most frequent occurrence: *Agropyrum glaucum*, *A. violaceum*, *Bouteloua oligostachya*, and *B. racemosa*, *Buchloa dactyloides*, *Koeleria cristata*, one or two *Festucas* and several *Poas*. Along water courses and in boggy places, as well as in over-irrigated places, these are replaced or become mixed with many species of *Juncus*, *Scirpus* and *Carex*. Sometimes Foxtail (*Hordeum jubatum*) takes complete possession.

The second class.—The plains strongly impregnated with alkali (sodium carbonate or sodium sulphate), are in some instances nearly devoid of vegetation, but more usually we find several characteristic plants. If the alkali be sodium sulphate the characteristic shrub is *Sarcobatus vermiculatus*, the well-known Grease Wood. On sodium carbonate soil, this, if not replaced by, has mingled with it some form of *Atriplex*, usually *A. confertifolia*, frequently called White Sage. Other species of *Atriplex*, mostly annuals, are found in this character of soil, and if the soil is very strongly impregnated, as on the shores of salt-marshes and partially dried up alkali lakes, the various species of *Atriplex*, of *Sueda* and of *Salicornea* are often the only vegetation. In real alkali bogs we find *Distichlis maritima*, *Triglochin maritima* and *T. palustre* as the most characteristic vegetation.

The other areas may be spoken of as the foot-hills and the mountains.

FLORA OF THE FOOT-HILLS.

Two kinds of foot-hills must be recognized, viz: wooded and denuded. The denuded slopes are of course much dryer and a large part of the year devoid of all streams. These foot-hills, if stony or gravelly, are covered with *Cercocarpus parvifolius*, *Rhus tridentata*, *Amelanchier alnifolia*, *Purshia tridentata*—one or more in varying proportion. The intervening valleys, if soil is fertile, are usually covered with sage brush. The herbaceous vegetation in such foot-hills is so varied that no list can be offered here, but the following genera are well represented: *Draba*, *Astragalus*, *Potentilla*, *Actinella*, *Erigeron*, *Senecio*, *Krynitzkia*, *Phlox*, *Penstemon*, and *Poa*.

If the soil contains alkali, the above-mentioned shrubs give place to Grease Wood, and the herbaceous vegetation largely disappears.

The wooded foot-hills are less common, but they occur at intervals in the Laramie range, much more frequently in the Medicine Bow Mountains and the Wind River range. The arboreal vegetation consists of only a few species, unless one includes the Willows that skirt most of the streams that flow from the higher mountains. Lodge Pole Pine, Douglas Spruce, Rocky Mountain White Pine, Black Cottonwood (*Populus angustifolia*) and more rarely Blue Spruce, Engelmann's Spruce and Rydberg's Cottonwood(*Populus acuminata*) are the most frequently met with. The shrubs are more varied and include, besides those mentioned for the drier hills, *Juniperus*, *Prunus*, Willows and Quaking Asp. The latter in some places becomes a small tree and is in fact found at all altitudes along streams or on hill-sides below snow

banks. The smaller vegetation likewise includes a much greater number of species, each of which apparently strives for the mastery and produces the most beautiful confusion of forms.

THE MOUNTAIN FLORA.

Some of the mountain ranges are quite heavily timbered, notably the Medicine Bow and Wind River ranges. The Laramie Mountains are wooded only in part and some of these areas very sparsely. Other ranges are known to be wooded, but I speak only of those I have visited. The summits of the Laramie Mountains are mostly rounded and undulating, and on these we find a scattering growth of Rocky Mountain Yellow Pine (*Pinus ponderosa scopulorum*) and occasionally some straggling, stunted specimens of the Virginia Juniper. Wherever we find the range broken by more abrupt slopes, deeper canons and water courses, the arboreal vegetation assumes the character of a forest, and in some districts furnishes valuable lumber. This is the case at Laramie Peak and on some of the spurs that run out from it. The forests consist mostly of Douglas Spruce, Rocky Mountain White Pine and Lodge Pole Pine.

Much the larger part of the Medicine Bow Mountains are heavily wooded, and it is from these forests that the larger part of the native lumber used in the southern part of the state is obtained. About the same species prevail as in the Laramie Mountains, with the addition of the Blue Spruce and Engelmann's Spruce. The White Pine (*Pinus flexilius*) and Douglas Spruce form much the larger part of the whole. The latter, along the streams at the foot of the ranges, reaches its greatest size and it grad-

ually comes to form a larger proportion of the whole until at 9,000 feet and upward it constitutes practically an unbroken forest to the exclusion of other species. At timber line it becomes scattering, dwarfed and depressed, spreading out like a huge mat under the enormous pressure of the winter snows.

Practically the same conditions prevail in the Wind River Mountains, and probably, though I cannot speak from observation, in the Big Horn Mountains.

Of the fruticose and herbaceous vegetation I need not speak here, although the summits of these ranges yield many beautiful and strictly alpine forms. These all receive comment in their proper place in the list, so space may not be consumed for that purpose here.

THE TREES OF THE STATE.

A list of the trees of the state is indeed very short and were those on the border line between trees and shrubs excluded in would be shorter yet by a third.

Rocky Mountain Yellow Pine (*Pinus ponderosa scopulorum*).
Rocky Mountain White Pine (*Pinus flexilis*).
Lodge Pole Pine (*Pinus Murrayana*).
Engelmann's Spruce (*Picea Engelmanni*).
Blue Spruce (*Picea pungens*).
Douglas Spruce (*Pseudotsuga Douglasii*).
Virginia Juniper (*Juniperus Virginiana*).
Black Cottonwood (*Populus angustifolia*).
Rydberg's Cottonwood (*Populus acuminata*).
Quaking Asp, Aspen (*Populus tremuloides*).
Willow (*Salix longifolia*).
Willow (*Salix flavescens*).
Willow (*Salix amygdaloides*).
Willow (*Salix lasiandra*).
Green Ash (*Fraxinus viridis*).
Box Elder (*Negundo aceroides*).

Scrub Oak (*Quercus undulata*)
Wild Plum (*Prunus Americana*).
Wild Cherry (*Prunus demissa*).
Wild Cherry (*Prunus Virginiana*).
Hawthorn (*Cratægus rivularis*).
Hawthorn (*Cratægus Douglasii*).
Service Berry (*Amelanchier alnifolia*).
(*Eleagnus argentea*).
Buffalo Berry (*Shepherdia argentea*).
Black Birch (*Betula occidentalis*).
Black Alder (*Alnus incana virescens*).
Sage Brush (*Artemisia tridentata*).

In a few localities of the state occasional specimens of Sage Brush attain a remarkable size—small trees in fact—so that a man on horseback may ride erect underneath the branches.

Other species have been reported but until the specimens are at hand they will not be listed. The number of shrubby plants is so great that to list them separately would be to reprint a large part of the succeeding systematic list.

THE FLORAS OF THE PACIFIC AND THE ATLANTIC SLOPES.

I have had no opportunity to compare the floras of the two regions except in so far as the plants on the western side of the Wind River range and those of Jackson's Hole and the Tetons, all of which are on the Pacific slope, may be compared with those on the eastern side of the Wind River Mountains and those of the south-eastern part of the state, which represent the Atlantic slope. Such examination has led to the conclusion that the continental divide, though dividing the waters, does not separate floras. The two regions have a far larger number

in common than they have of forms that are distinct. While my collection lists show much that is different, I firmly believe that the difference is due mainly to the season in which each was collected. I am confirmed in this by an examination of the lists given in Dr. J. M. Coulter's report on the Botany of the Hayden U. S. Geological Survey, 1872. These lists comprise those collected, 1. On both slopes; 2. Only on the eastern slope, and 3. Only on the western slope. Those of the last list were collected in the earlier part of the season, and a remarkable number are the same as those of my list for the eastern slope during the same months. Different localities and seasons yield different results, but complete collections would reveal no abrupt transitions; Iowa and Utah, for instance, have different floras, but any fifty or one hundred miles between, even at the summit of the Rockies, will show only the most gradual substitutions. One form disappears, a new one appears, but this occurs with a change of locality in any direction. On the plains of the Platte and its tributaries *Cleome integrifolia* only is found, while on Wind River and its tributaries *Cleome lutea* is the only form.

INTRODUCED PLANTS.

By introduced plants reference is made only to such as grow without cultivation. Most of them may properly be called "Weeds." This is an ever-growing list and will soon include a large part of those familiar to the eastern farmer. The extension of our agricultural interests of course includes the importation of seed, and rarely is any kind of seed free from weed seeds. Some of our weeds, however, are native plants and thrive immensely

under cultivation. Those of special interest receive notice in the proper place in the list, and possibly a future bulletin may deal with the weed problem in this state.

HARDINESS OF NATIVE PLANTS.

The power to withstand frost, so remarkably developed in mountain floras, has undoubtedly often been remarked upon before, but it is, nevertheless, unceasingly a cause of wonder. To see great beds of Phlox, Mertensia, Gilia, Actinella and scores of others in full bloom at times when the temperature at night is 5° to 20° F., below the freezing point is a phenomenon that can scarcely be explained. That reduced atmospheric pressure plays an important part in preventing injury, I think must be accepted, for the same plants at lower altitudes would perish. The following observation goes to prove this: Late in August in 1890, a plot of potatoes was noted in full blossom at Mountain Home, elevation about 9,000 feet. Observations on three successive days showed no trace of injury though on both of the intervening nights there were heavy white frosts and films of ice formed on water pails. Such a degree of cold would have absolutely killed potatoes at sea-level.

FLORAL CALENDAR.

In 1894 every effort was made to keep pace with the floral procession. At the altitude of the Laramie Plains, (7,000 feet), Spring opens comparatively late. April furnishes very few objects of interest to the botanist. The earliest flowers are *Phlox cæspitosa* and *Townsendia sericea*, both of which expand their blossoms scarcely above the surface of the ground. These are soon followed by

some small *Umbelliferæ*, among which *Cymopterus montanus* may be noted. Toward the end of the month a few more begin to appear on the plains and in the foot-hills, all of which possess either large, fleshy, perennial roots, as *Leucocrinum montanum*, *Musenium trachycarpum* and *Peucedanum nundicaule*, or else they have large woody subterranean stems from which spring the small leaves and numerous flowers that spread out in dense mats or cushions upon the cold soil. Such are *Astragalus spatulatus* and *Astragalus sericoleucus*. Among the rocks in sheltered nooks are also two *Mertensias*, *lanceolata* and *alpina*. With the advent of May, or sometimes earlier, the little *Drabas*, *glacialis* and *alpina* tinge the naked rocks with yellow. In the moister canons our earliest Buttercup, *Ranunculus glaberrimus*, and the Wind-flower, *Anemone patens Nuttalliana*, are found.

Very slowly through May, for cold days and snow-storms are far from rare, the number grows so that the diligent observer may find several score. From this time on the forms crowd upon each other in rapid succession and one soon loses track of the order of their coming. June is the floral month of the plains, July of the lower mountains and August is the month of months in the high altitudes. September has something of worth everywhere and a few forms linger late into October.

BOTANICAL WORK IN THE STATE.

So far as I have been able to learn there are no other workers in systematic botany in the state, nor are there any other herbaria, public or private. On this account I have been unable to make comparison of our specimens with those from other localities in the state.

As before stated the following list is based wholly upon specimens in our herbarium. Plants reported as in the state are not included but appended in separate lists, each under heads showing by whom and from what locality reported.

NOMENCLATURE AND CITATIONS.

As the discussion of the nomenclature question is still waxing warm, happily with less acerbity than before, it has seemed almost a matter of indifference what view of the question was taken with reference to this report. Not that it is a matter of indifference to any worker in the field of botany, but the question seems so far from settlement that one may still expect almost any solution. Stability is the object all have in view and those who publish work of any kind will use that nomenclature which seems to them to offer the greatest chances for permanency. So long as different adherents of the so-called "new nomenclature" are far from agreed among themselves, as witness recent publications, there is small inducement to abandon a fairly satisfactory system. That there is room for improvement none will deny, but until there is international agreement we shall hardly reach a permanent, much less an ideal nomenclature.

I greatly regret that citations in many instances are quite incomplete. Meager library facilities must be my excuse.

Where the recent "List of Pteridophyta and Spermaphyta of the Northeastern United States" recommends a name, different from that used in this report, such name is given as a synonym without citation.

For the citations given I am often indebted to the

above list; to recent publications from the Division of Botany, U. S. Dept. of Agriculture; to various publications from the Gray Herbarium and to several other papers and reports.

CRYPTOGAMS.

In 1894 no Cryptogams were collected except a few Ferns. In 1895 efforts were made to secure the Mosses as well. No attention was given to the other groups but incidentally a few Lichens and Fungi were picked up. In future collecting it is purposed to give more attention to this part of the flora.

ACKNOWLEDGEMENTS.

I have pleasure in acknowledging the generous assistance of the various members of the collecting party of 1894. To Prof. W. C. Knight I am indebted for specimens and information in the field and subsequently for literature and data upon various topics. The services rendered by Prof. B. C. Buffum in the field I have previously mentioned; his continued interest and occasional assistance is greatly appreciated. To Mrs. Celia A. Nelson much credit is due for her painstaking care in the preparation of specimans and her devotion to the work during the expeditions of 1895. The task of putting this manuscript in shape for the printer is work for which I am also largely indebted to her.

For assistance in the determination of certain groups I am greatly indebted to the following specialists: To Dr. B. L. Robinson, to whom a considerable number were submitted for comparison and determination. For careful reports upon these I am indebted to him and Mr. M. L. Fernald. Certain orders and genera were sub-

mitted only in part as follows: *Astragalus* to Prof. E. P. Sheldon; *Umbelliferæ* to Dr. J. N. Rose; *Juncus* to Dr. F. V. Coville; *Gramineæ* to Dr. F. Lamson-Scribner; *Carex* to Prof. L. H. Bailey; *Salix* to the late Mr. M. S. Bebb; *Filices* to Prof. L. M. Underwood; *Musci* to Prof. J. M. Holzinger; *Fungi* to Mr. J. B. Ellis; *Lichens* to Dr. J. W. Eckfelt. Lastly I would mention the kindness of Prof. E. L. Greene, who has furnished determinations, corrections and valuable suggestions on a number of miscellaneous specimens.

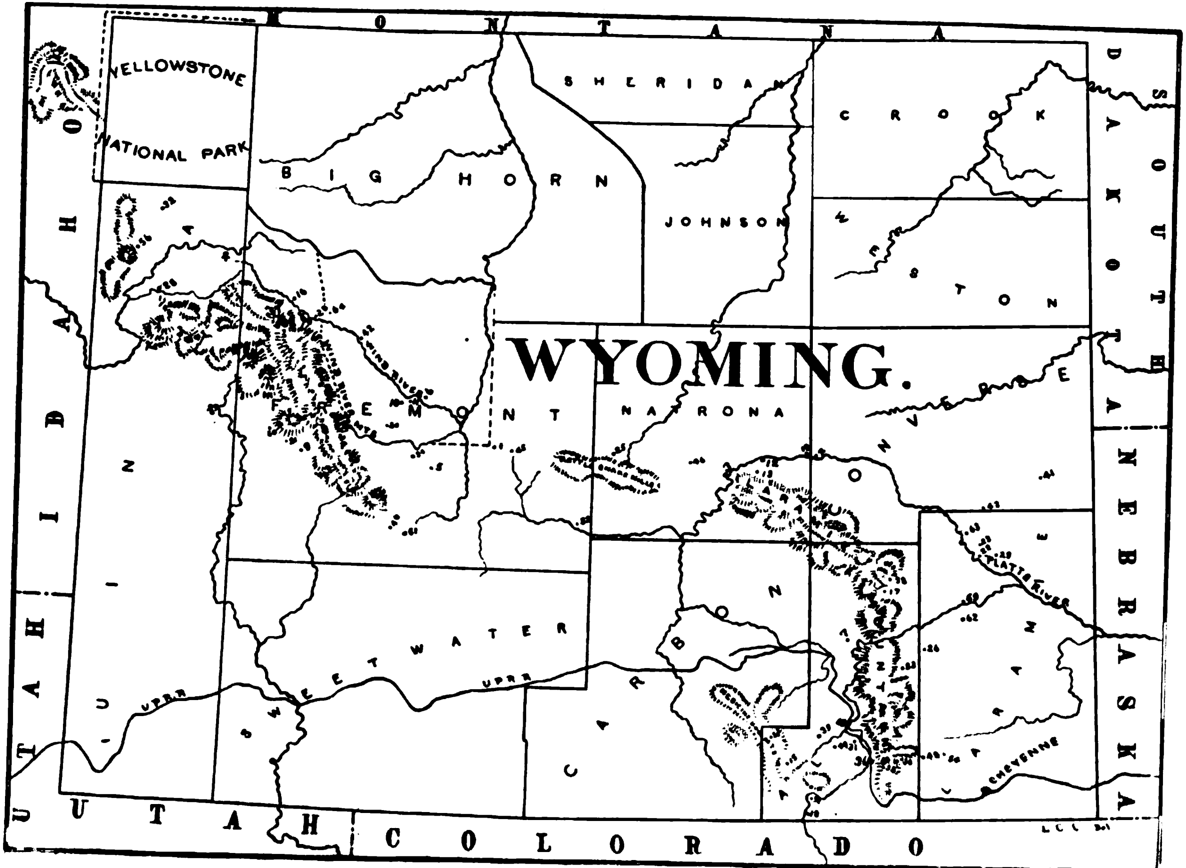
EXPLANATIONS.

All comments upon plants, such as rare, frequent, etc., refer to this state and in particutlar to those parts of the state which this report covers. The number in parenthesis following the comments upon each species is the collection number and will render reference to the specimen easy in case any are found incorrectly determined.

PRINCIPAL CAMPS AND COLLECTING LOCALITIES.

The following table contains the principal points in the neighborhood of which most of the material was secured. The altitudes given are only approximate and for hills, mountains, etc., the extremes may be less or greater than given.

NO.	PLACE.	COUNTY.	ELEVATION—FT.
1.	Alkali Springs	Fremont	5500
2.	Bacon Creek	Uinta	7000-8000
3.	Bessemer	Natrona	5300
4.	Big Muddy Creek	Converse	5000
5.	Big Popo Agie River	Fremont	5200
6.	Big Wind River	Fremont	5200
7.	Blue Grass Creek	Albany	6000-7000
8.	Blue Grass Hills	Albany	6500
9.	Boulder Creek	Fremont	7400
10.	Bull Lake	Fremont	5350
11.	Bull Lake Creek	Fremont	5200
12.	Casper	Natrona	5200
13.	Casper Mountain	Natrona	5500-6500
14.	Centennial Hills	Albany	8000-9500
15.	Centennial Valley	Albany	7500-8000
16.	Clark's Ranch	Fremont	7200
17.	Cottonwood Canon	Albany	6000-6500
18.	Cummins, vicinity of	Albany	8000-9000
19.	C. Y. Ranch	Converse	5000
20.	Dubois	Fremont	7000
21.	East Fork	Fremont	7300
22.	Fairbanks	Laramie	4200
23.	Ford J. Ranch	Laramie	4500
24.	Fort Washakie	Fremont	5200
25.	Garfield Peak	Natrona	6000-8000
26.	Grant	Laramie	6000
27.	Green River	Uinta	8000
28.	Gros Ventre River	Uinta	7000
29.	Hartville	Laramie	4500
30.	Horse Creek	Albany	7300-7800
31.	Howell Lakes	Albany	7000
32.	Jackson's Hole	Uinta	6500
33.	Jelm Mountain	Albany	8000-9000
34.	Lander	Fremont	5300
35.	La Plata Mines	Albany	11000
36.	Laramie	Albany	7200
37.	Laramie Hills	Albany	7500-8500
38.	Laramie Peak	Albany	7000-9000
39.	Laramie Plains	Albany	7000
40.	Little Sandy	Fremont	7000
41.	Lusk	Converse	5000
42.	Meadow Creek	Fremont	6500
43.	Mexican Mines	Converse	4750
44.	Muddy Creek	Fremont	7000
45.	Musk-rat Creek	Fremont	5500
46.	Platte River	Laramie	4200
47.	Poison Spider Creek	Natrona	5500-6000
48.	Pole Creek	Albany	7000-8000
49.	Seven-mile Lake	Albany	7000
50.	Silver Creek	Fremont	7000
51.	South Pass City	Fremont	7500
52.	Sweetwater River	Fremont	6000-7000
53.	Sybille Creek	Albany	6000-7000
54.	Table Mountain	Laramie	7000-8000
55.	Telephone Canon	Albany	7500-8000
56.	Teton Mountains	Uinta	7000-11000
57.	Union Pass	Fremont	8000-10000
58.	Union Peak	Fremont	10000-11000
59.	Uva	Laramie	4500
60.	Warm Spring Creek	Fremont	8000
61.	Whalen Canon	Laramie	4750
62.	Wheatland	Laramie	4700
63.	Willow Creek	Laramie	4500
64.	Wind River, North Fork of	Fremont	6500



MAP OF PRINCIPAL COLLECTING POINTS.

The numbers are those of the accompanying Table of Localities.

LIST OF SPECIES.

RANUNCULACEÆ.

Clematis ligusticifolia, Nutt, Torr. & Gray, Fl. i, 9 (1838).

From type locality, viz: "Plains of the Rocky Mountains, in open and in bushy places near streams." Rather frequent.

Blue Grass Creek, Fl. July 8, 1894 (No. 361); Popo Agie River, Fr. August 3, 1894 (No. 712). *Virgin's Bower.*

Clematis Douglasii, Hook. Fl. Bor. Am. i, 1 (1829).

Observed only in one locality, on open hillside.

Laramie Hills, June 9, 1894 (No. 202).

Clematis verticillaris Columbiana, M. E. Jones.

Infrequent, on moist wooded hillsides.

Pole Creek, May 25, 1894 (No. 72).

Thalictrum Fendleri, Engelm. Gray Pl. Fendl. 5.

Common in wet Meadows.

Horse Creek, June 9, 1894 (No. 189); East Fork, August 25, 1894 (No. 1119). *Meadow Rue.*

Thalictrum occidentale, Gray. Proc. Am. Acad. viii, 372.

In thickets along mountain streams, variable as to number of akenes which sometimes are 7-12.

Jackson's Hole, August 20, 1894 (No. 937); Gros Ventre, August 25, 1894 (No. 1067).

Thalictrum purpurascens, L. Sp. Pl. 1753.

Found but once, probably confined to the north and east.

Whalen canon, July 17, 1894 (No. 512);

Thalictrum sparsiflorum, Turcz. in Ind. Sem. Petr. i, 40.

On mountain streams, 8000 ft. and upward.

Cummins, July 30, 1895 (No. 1494).

Anemone cylindrica, Gray, Ann. N. Y. Lyc. iii, 221.

Not common, in fertile valleys, near streams.

Laramie Peak, August 5, 1895 (No. 1583).

Anemone multifida, Poir, Suppl. i, 364.

Infrequent, moist mountain valleys.

Laramie Hills, June 22, 1894 (250), B. C. Buffum; Upper Wind River, August 10, 1894 (No. 756).

Anemone patens Nuttalliana, Gray, Man. Ed. 5, 36 (1867). *Pulsatilla hirsutissima.* (Pursh) Britton.

One of the earliest flowers, on moist, rich canon-sides.

Laramie Hills, Fl. May 4, 1894 (No. 2); Fr. May 29. *Wind Flower.*

Anemone Pennsylvanica, L. Mant. ii, 247. *A. Canadensis,* L.

Very abundant on streams in the eastern part of the state.

Pole Creek, June 2, 1894 (No. 139); Sybille Creek, July 8, 1894 (No. 406).

Ranunculus acriformis, Gray, Proc. Am. Acad. xxi, 374.

Common on creek and river bottoms, at least in Albany county.

Horse Creek, June 9, 1894 (No. 199); Little Laramie River, June 9, 1895 (No. 1306). *Buttercup.*

Ranunculus affinis cardiophyllus, Gray, Proc. Acad. Phila. 56 (1863).

This seems to be a good variety, easily distinguished from var. *validus,* Gray, by the smaller size of the plant, and by the thinner leaves which are either somewhat acute or show a tendency to become divided. Mountain meadows at 7000-8000 ft. Pole Creek, June 2, 1894 (No. 126).

Ranunculus affinis validus, Gray.

Wet meadows, Horse Creek, June 9, 1894 (No. 195).

Ranunculus alismæfolius, Geyer. Benth. Pl. Hartw. 295 (1839).

This is not quite typical and is probably var. *montanus,* Watson, or *R. alismellus,* Greene. Medicine Bow Mountains, at 11,000 ft. August 23, 1895 (No. 1762).

Ranunculus aquatilis trichophyllus, Gray, Man. Ed. 5, 40 (1867). *Batrachium trychophyllum,* (Chaix) Bossch.

Common in slow-moving streams. Muddy Creek, August 25, 1894 (No. 1112).

Ranunculus Cymbalaria, Pursh, Fl. Am. Sept. 392 (1814). *Cyrtorhyncha Cymbalaria,* (Pursh) Britton.

Very common in wet alkali soils. Laramie, at various times, the plant remaining in blossom throughout the season; Lander, August 3, 1894 (No. 693).

Ranunculus Eschscholtzii, Schlecht. Animad. Ranunc. ii, 16.
Union Peak, August 13, 1894 (No. 1003); Medicine Bow Mountains, at 11,000 ft., August 22, 1895 (No. 1780).

Ranunculus eximius, Greene, Erythea iii, 19 (1895).
A most beautiful large-flowered species collected by B.C. Buffum at Bald Mountain, August 15, 1892. The specimens in our herbarium are in part the ones from which the original description was drawn.

Ranunculus flammula reptans, Mey. Pl. Lab. 96 (1836). *R. reptans*, L.
Not common, creeping among the stones on the shore of Bull Lake Creek, August 9, 1894 (No. 729).

Ranunculus glaberrimus, Hook. Fl. Bor. Am. i, 12, t. 5.
Our specimens are the form represented by Prof. Greene's *R. ellipticus*, Pittonia, ii, 110. Our earliest Buttercup; very abundant among the sage brush in moist valleys; Laramie Hills, April and May, 1894 (No. 3).

Ranunculus Macounii, Britton, Trans. N. Y. Acad. Sci. xii, 3 (1892).
Frequent on low-lying wet lands; Big Wind River, August 9, 1894 (No. 723); Cummins, July 29, 1895 (No. 1483).

Ranunculus natans, C. A. Mey. in Ledeb. Fl. Alt. ii, 315.
In the mountains, on the muddy banks or in the water of partially dried up lakes. Union Pass, August 10, 1894 (No. 808); East Fork, August 27, 1894 (No. 1113).

Ranunculus Nuttallii, Gray, Proc. Acad. Phila. 56 (1863). *Cyrtorhyncha ranunculina*, Nutt.
Very abundant on rocky ridges at 8,000-9,000 ft. Laramie Hills, May and June, 1894 and 1895 (Nos. 76 and 1237).

Ranunculus Purshii, Richards. Frank. Journ. 741 (1823).
In the bed of a recently dried up lake, Union Pass, August 14, 1894 (No. 880).

Ranunculus rhomboideus, Goldie. Edinb. Phil. Journ. vi. 329 (1822). *R. ovalis*, Raf.
Rare, observed only in wet meadows on Pole Creek, May 25, 1894 (No. 78).

Ranunculus sceleratus, L. Sp. Pl. 551 (1753).
Abundant in shallow spring pools; Fairbanks, July 14, 1894 (No. 453).

Caltha leptosepala, D. C. Syst. i, 310.

Very abundant in wet grounds at 9,000- 10,000 ft., greedily eaten by elk and locally called "Elk Slip." Union pass. August 13, 1894 (No. 1023).

Trollius laxus, Salisb. Trans. Linn. Soc. viii, 303 (1803).

In the mountains at 9,000 ft. and upward. Union Pass, August 14, 1894 (No. 886); Medicine Bow Mountains, August 22, 1895 (No. 1709).

Aquilegia cærulea, James. Long's Exped. ii, 345.

The queen of Columbines, superbly handsome. In the woods at 8,000-10,000 ft. Laramie Hills, June 22, 1894 (No. 249), B. C. Buffum.

Aquilegia cærulea alpina, n. var.

This, it seemed to me, must be *A. pubescens*, Coville, but Dr. Robinson thinks it is rather a form of *caerulea.* Further examination convinces me that this is right. It is hardly Dr. Gray's var. *albiflora*, for these specimens are all distinctly yellow and in habitat strictly alpine. The variety differs from the species in the smaller size of the plant and larger leaves with upper leaflets entire; in the smaller flowers and very much shorter spurs.

Possibly confined to the Wind River Mountains, where it occupies crevices and ledges of the naked summits above timber line. Observed by Prof. B. C. Buffum, in such locations in 1892 and collected by the writer on Union Peak at 10,500 ft., August 13, 1894 (No. 894).

Aquilegia Laramiensis, n. sp.

Many stemmed from a rather large, semi-fleshy root; 6-9 inches high. The stems and petioles inclined to be decumbent and diffuse. Spurs short, hooked and knobbed. Slightly pubescent on the underside of leaves, on flowers, follicles and pedicels. Sepals greenish white, lanceolate with emarginate apex; lamina, of the light cream-colored petals, obtuse elliptical, longer than the spur.

It differs from *A. saximontana* in its greater pubescence and larger leaflets; from *A. brevistyla* in having longer petioles with dilated bases; from *A. flavescens* in habit and especially in habitat.*

*I am indebted to Dr. Robinson for making comparison of this with the nearly related species.

Collected at the foot of Laramie Peak, in the Laramie range, in a canon where it occupied the dry crevices in abrupt cliffs.

Delphinium azureum (?) Michx. Fl. Bor. Am. i, 314 (1803). *D. Carolinianum*, Walt.

Not quite typical but probably a form of this species. Saratoga, June 1893. J. D. Parker.

Delphinium bicolor, Nutt. Journ. Acad. Phila. vii, 10.

Our earliest Larkspur, in dry loam soil of ravines and hillsides.

Telephone Canon, May 23, 1894 (No. 48); Table Mountain, June 28, 1895 (No. 1385).

Delphinium Geyeri, Greene.

A good species, immensely abundant on the Laramie Plains. Frequently greedily eaten by hungry cattle with fatal results, caused by bloating, hence the local common name, "Poison Weed." Laramie Hills, July 10, 1894 (No. 400); South Laramie Plains, July 31, 1895 (No. 1552).

Delphinium scopulorum glaucum, Gray. Bot. Gaz. xii, 52. *D. glaucum*, Wats.

In the mountains at 8,000-9,000 ft.; Union Pass, August 10, 1894 (No. 874); Laramie Peak, August 7, 1895 (No. 1599).

Delphinium scopulorum subalpinum, Gray. Bot. Gaz. xii, 52.

A very beautiful alpine form. LaPlata Mines, 11,000 ft., August 22, 1895 (No. 1761).

Aconitum Columbianum, Nutt. T. & G. Fl. i, 34.

Two marked forms occur: The typical one, tall, large-leaved and dark blue or purple flowered; the other, repeatedly observed, has light yellow flowers, the plant is smaller, leaves smaller and less pubescent. Less striking differences have sometimes been held to be specific, so it seems proper that this at least bear the varietal name *ochroleucum*. The former is common in thickets on mountain streams. Collected at Snake River, August 21, 1894 (No. 939); Cummins, July 29, 1895 (No. 1521). The latter, less frequent, in similar locations; collected at Cummins and in Centennial Valley and observed at Laramie Peak.

Actea spicata arguta, Torr. Pacif. R. Rep. iv, 63.

White and red berried forms occasionally found growing together. Garfield Peak, July 29, 1894 (Nos. 681 and 692); Cummins July 27, 1895 (No. 1490).

BERBERIDACEÆ.

Berberis Repens, Lindl. Bot. Reg. t. 1176 (1828).

Common among the rocks in hilly regions. Laramie Hills, May 25, 1894 (No. 66); Centennial Hills, August 1895.

NYMPHÆACEÆ.

Nuphar polysepalum, Engelm. Trans. St. Louis Acad. ii, 283 (1865). *Nymphæa polysepala,* (Engelm.) Greene.

Sub-alpine ponds and lakes, not common.

Medicine Bow Mountains, by Col. S. W. Downey; Union Pass, August 14, 1894 (No. 898). *Yellow Pond Lily.*

PAPAVERACEÆ.

Argemone platyceras. Link & Otto, Icon. i, 85. t, 43 (1828). *Argemone albiflora,* Hornem.

Common on the eastern slopes of the Laramie Hills.

Chugwater Station, B. C. Buffum, July 14, 1891; Sybille Hills, July 8, 1894 (No. 314); Table Mountain, July 1, 1895 (No. 1363). *Poppy.*

FUMARIACEÆ.

Corydalis aurea, Willd. Enum 740 (1809). *Capnoides aureum,* (Willd) Kuntze.

This and the following occurs frequently in dry sandy ravines and on the adjoining hillsides.

Centennial Valley, August 19, 1895 (No. 1679).

Corydalis aurea occidentalis, Engelm.

The variety is far more common than the species.

Telephone Canon, June 3, 1894 (No. 118); Laramie, June 5, 1895 (No. 1241).

CRUCIFERÆ.

Nasturtium obtusum, Nutt. T. & G. Fl. N. A. i, 74 (1838). *Roripa obtusa* (Nutt.) Britton.

Usually found growing in spray of minature waterfalls.

East Fork, August 25, 1894 (No. 1116); Pole Creek, July 2, 1895 (No. 1415).

Nasturtium officinale, R. Br. in Ait. Hort. Kew. Ed. 2, iv, 110 (1812). *Roripa Nasturtium.* (L.) Rusby.

Not common, but introduced into some of the springs about Laramie and probably elsewhere in the state.

State Fish Hatchery, September 24, 1894 (No. 1152). *Water Cress.*

Nasturtium palustre, DC Syst. Veg. ii, 191 (1821). *Roripa palustris,* (L.) Bess.

Only rarely seen, wet lowlands.

C. Y. Ranch, on Big Muddy, July 24, 1894 (No. 638).

Nasturtium palustre hispidum, Fisch & Mey. Ind. Sem. Petr. iii, 41. *Roripa hispida* (Desv.) Britton.

This was found twice but only a specimen or two at a time.

Sybille Creek, July 9, 1864 (No. 300.); South Pass, September 2, 1894 (No. 1185).

Nasturtium sinuatum, Nutt. T. & G. Fl. N. A. i, 73 (1838). *Roripa sinuata,* (Nutt.) A. S. Hitchcock.

Apparently quite common, a weed on the campus and on the Experiment farm. (No. 281).

Nasturtium sp.?

A single specimen collected by B. C. Buffum at Bald Mountain, no fruit. Its affinities are not readily made out at this stage but evidently is none of the above.

Barbarea vulgaris, R. Br. in Ait. Hort. Kew, Ed. 2, iv, 109 (1812). *B. Barbarea,* (L.) Mac M.

Union pass, August 10, 1894 (No. 864); Stout plants, thick pods but otherwise normal.

Arabis.

(For this and a few other genera see appendix.)

Thelepodium. (See appendix.)

Cardamine Breweri, Watson, Proc. Am. Acad. x, 339.

Common, at the water's edge in many of our streams. Pole Creek, June 2, 1894 (No. 158); Cummins, July 28, 1895 (No. 1465).

Cardamine cordifolia, Gray, Pl. Fendl. 8.

On stream banks in mountain thickets, quite infrequent. Cummins, July 27, 1895 (No. 1488).

Cardamine Pennsylvanica, Muhl. Sp. Pl. 3: 486 (1800).

Found but once, Lander Creek, August 30, 1894 (No. 1106).

Lesquerella Ludoviciana, Watson, Proc. Am. Acad. xxiii. 252 (1888). *Vesicaria Ludoviciana,* D. C.

Remarkably abundant on the Laramie Plains, in dry sandy soil. June 1, 1894 (No. 190).

Lesquerella montana, Watson, l. c. 251. *Vesicaria montana,* Gray.

Very abundant on the sandy, stony foothills of the Laramie range. Table Mountain June 2, 1894 (No. 88); Pole Creek, June 30, 1895 (No. 1370).

Physaria didymocarpa, Gray, Gen. Ill. i. 162 (1848).

In gravelly clay banks, infrequent, not readily distinguished from Lesquerella until the pods begin to mature. Gros Ventre River, August 16, 1894 (No. 927); Cummins, July 30, 1895 (No. 1555).

Draba. (See appendix.)

Draba alpina, L. Sp. Pl. ii, 642 (1753).

Abundant, on stony gravelly ridges on the plains and in the foothills. Laramie Hills, May 4, 1894 (No. 4); Laramie River Divide, June 9, 1895 (No. 1223).

Draba crassifolia, Graham, Edinb. New Phil. Journ. 182 (1829).

Infrequent, damp, shaded ground; LaPlata Mines, August 21, 1895 (No. 1838).

Draba glacialis, Adams, Mem. Soc. Nat. Mosc. v, 106.

Frequent and of similar habitat as *D. alpina.* Maturing fruit early in May. (Nos. 62 and 1218).

Draba stenoloba, Ledeb. Fl. Ross. i, 154 (1841).

Very rare, collected by B. C. Buffum, in a gulch near Bald Mountain, August 15, 1892.

Sisymbrium canescens, Nutt. Gen. ii, 68.

As variable as it is frequent in occurrence. Table Mountain, June 30, 1895 (No. 1321); Laramie, June 16, 1894 (No. 247).

Sisymbrium incisum, Engelm. Gray Pl. Fendl. 8.

Difficult to separate from some of its varieties. Wheatland, July 9, 1894 (No. 475); South Pass, August 31, 1894 (No. 1184).

Sisymbrium incisum filipes, Gray, Pl. Fendl. 8.

Not at all common; Laramie, August 1893; near Table Mountain, June 30, 1895 (Nos. 1349 and 1425).

Sisymbrium incisum Hartwegianum, Wats, Bot. cal. i, 41.

Observed but once; Sand Creek, August 26, 1894 (No. 1100).

Sisymbrium linifolium, Nutt. T. & G. Fl. i, 91.

Abundant and of frequent occurrence on the plains and in the foothills. Laramie, June 12, 1894 (No. 173); June 1895 (No. 1420).

Smelowskia calycina, C. A. Meyer, Ledeb. Fl. Alt. iii, 165.

Very rare, found but once and then but a plant or two; Laramie Hills, June 1893.

Erisymum asperum Arkansanum, Gray, Man. Ed. 5, 69.

This variety is of very frequent occurrence; in early summer it forms a very conspicuous object on the sandy plains and hillsides in Albany county. Table Mountain, June 2, 1894 (No. 87); Two Bar Ranch on Blue Grass Creek, July 9, 1894 (No. 377).

Erisymum cheiranthoides, L. Sp. Pl. 661 (1753).

Widely distributed but not particularly abundant; Sybille Creek, July 8, 1894 (No. 404); South Pass, September 1, 1894 (No. 1187), and Cummins, July 30, 1895 (No. 1462).

Erisymum parviflorum, Nutt. T. & G. Fl. N. A. i, 95 (838.) *E. inconspicuum.* (Wats.) MacM.

Frequent; Laramie, June 20, 1894 (No. 221); Bacon Creek, August 15, 1894, (No. 916).

Stanleya pinnatifida, Nutt. Gen. ii, 71 (1818). *S. pinnata,* (Pursh) Britton.

Only occasionally, on dry gravelly banks; Little Laramie River, June 6, 1894, by Mr. Houghton; Wood's Landing, July 31, 1895 (No. 1554).

Stanleya pinnatifida integrifolia, Robinson, Syn. Fl. i, 179 (1895).

This form much less common; stems numerous from a large deep-set root; on the dry plains west of Laramie, August 26, 1895, (No. 1845).

Stanleya viridiflora, Nutt. T. & G. Fl. i, 98.

Very rare, not found at all by the writer; collected at Wheatland, June 16, 1892, B. C. Buffum.

Brassica campestris, L. Sp. Pl. 666 (1753).

Occasionally seen in waste places about town; Laramie, September 15, 1893.

Brassica sinapistrum, Boiss. Voy. Espagne, ii, 39 (1839-45).

A single specimen from Centennial Valley, August 25, 1895, (No. 1876).

Capsella Bursa-Pastoris, Medic. Pfl. Gatt. i, 85 (1792). *Bursa Bursa-Pastoris*, (L.) Weber.

A weed in lawns and dooryards everywhere; University Campus, June 1891.

Lepidium apetalum, Willd. Spec. iii, 439.

Quite common on the Laramie Plains, in some places becoming a weed.

Blue Grass Hills, July 8, 1894 (No. 323); University Campus, July 22, 1895 (No. 1424).

Lepidium montanum, Nutt. T. & G. Fl. i, 116, 669.

Rare, State Fish Hatchery grounds, Laramie, B. C. Buffum, 1892; Carbon, June 18, 1894 (No. 257), Miss Lily Boyd.

Lepidium Virginicum, L. Sp. Pl. 645 (1753).

Occasionally found introduced into lawns and vacant lots. Laramie, June 15, 1891, B. C. Buffum.

Thlaspi alpestre, L. Sp. Pl. ii, 903.

The typical form of this species is abundant in the Laramie Hills on open hillsides at 7,000-8500 ft. Telephone Canon, May 21, 1891, B. C. Buffum; Pole Creek, May 12, 1894 (No. 28).

Thlaspi alpestre glaucum, n. var.

The perennial basal part of stem rather freely branched, herbaceous stems simple and erect, 6-10 inches high; radical leaves broadly to narrowly elliptical, entire or obscurely repand-denticulate; cauline deltoid-auriculate entire. It also differs from the species in the glaucus hue of the leaves, the laxer inflorescence and well marked notch at the apex of the capsule as well as in its habitat. The species flowers in early spring on open hillsides; the variety was collected in the forest almost at timber line, growing in the thick beds of Spruce needles. La Plata Mines, August 21, 1895 (No. 1777).

CAPPARIDACEÆ.

Cleome integrifolia, T. & G. Fl. i, 142.

An obnoxious weed, sometimes occupying acres of ground to the exclusion of everything else. Everywhere on the Laramie plains, and, in fact, all over the south-eastern part of the state. Laramie, June 24, 1894 (No. 297).

Cleome lutea, Hook. Fl- Bor. Am. i, 70, t. 25.

This seems to replace the preceding on the Wind Rivers and in the north-west generally; in sandy soil. Big Wind River, August 5, 1894 (No. 701).

Polanisia trachysperma, T. & G. Fl. N. A. i, 669 (1840).

Widely distributed in the state but not very abundant; on sandy banks. Laramie Plains July 10, 1894 (No. 333); and B. C. Buffum, at Wheatland.

VIOLACEÆ.

Viola blanda, Willd. Hort. Berol. t, 24 (1806).

Quite rare, on mossy bank in the light spray of a little waterfall. Centennial Hills, June 9, 1895 (No. 1257).

Viola Canadensis, L. Sp. Pl. 936 (1753).

Abundant in thickets along streams.

Head of Pole Creek, May 25, 1894 (No. 44); Near Table Mountain, July 2, 1895 (No. 1406).

Viola canina adunca, Gray, Proc. Am. Acad. viii, 377,

Occurs less frequently than the following, leaves less crowded on the rootstock.

Pass Creek June 20, 1892, B. C. Buffum; Horse Creek, June 9, 1894 (No. 209).

Viola canina Muhlenbergii, Traut. Act. Hort. Petrop. v, 28.

Widely distributed, rather abundant and variable.

Pole Creek June 2, 1894 (No. 146); Centennial Valley, June 9, 1895 (No. 1284).

Viola Nuttallii, Pursh, Fl. Am. i, 174 (1814).

The earliest and commonest Violet on the plains.

Laramie, May 19, 1894 (No. 37); May 23 1895 (No. 1229).

Viola palmata cucullata, Gray, Bot. Gaz. xi, 254 (1886).

Infrequent. Horse Creek, June 9, 1894 (No. 191).

Viola palustris, L. Sp. Pl. ii, 934 (1753).

A beautiful little plant observed but once, on a boggy bank.

Pole Creek, June 2, 1894 (No. 140).

Viola præmorsa, Dougl. Lindl. Bot. Reg. i, 1254.

This must be very rare in the state and its occurrence here extends its range considerably. Observed both in 1894 and in 1895, only at the head of Pole Creek, May, (Nos. 43 and 1215).

CARYOPHYLLACEÆ.

Saponaria Vaccaria, L. Sp. Pl. 409 (1753).

This is becoming a troublesome weed in some parts of the state. From the Big Horn Mountains, by B. C. Buffum in 1892; Wheatlond, July 11, 1894 (No. 474).

Silene acaulis, L. Sp. Pl. ii, 603 (1762).

Strictly alpine, Teton Mountains, August 21, 1894 (No. 973); Medicine Bow Mountains, August 22, 1895 (No. 1828),

Silene antirrhina, L. Sp. Pl. 419 (1753).

Widely distributed and not rare. Platte River, July 14, 1894 (No. 493); Centennial Valley, August 17, 1895 (No. 1658).

Silene Douglasii multicaulis, Robinson, Contr. Gray, Herb. 144 (1893).

Union Pass at 10,000 ft., August 13, 1894 (No. 1019).

Silene Douglasii viscosa, Robinson, l. c. 145.

This is not quite typical but Dr. Robinson thinks it too near to be separated. Union Pass, August 11, 1894 (No. 845).

Silene Hallii, Watson, Proc. Am. Acad. xxi, 446.

On grassy, open slopes at high elevations; LaPlata Mines, August 21, 1895 (No. 1829).

Agrostemma Githago, L. Sp. Pl. 435 (1753).

As yet very rare in the state. Collected at Sugg's Road by B. C. Buffum August, 1891.

Cerastium alpinum Behringianum, Regel. Ost. Sib. i, 435.

Not common even in the mountains; Union Peak, August 13, 1894 (No. 1013).

Cerastium arvense, L. Sp. Pl. 438 (1753).

Very abundant in early summer in the Laramie Hills. Pole Creek, June 2, 1894 (No. 138); near City Springs, June 21, 1891, B. C. Buffum.

Cerastium arvense latifolium, Fenzl. Ledeb. Fl. Ross. i, 412.

Frequent on rocky hills and ledges in the mountains; Laramie Hills, May 24, 1894 (No. 41).

Cerastium arvense maximum, Hollick and Britton, Bull. Torr. Club, xiv, 45.

Apparently rare; near the creek bank on lower Pole Creek, July 1, 1895 (No. 1380).

Cerastium nutans, Raf. Prec. Dec. 36 (1814). *C. longipedunculatum* Muhl.

Collected only in the north-western part of the state; Bacon Creek, August 16, 1894 (No. 924).

Stellaria borealis, Bigel, Fl. Bost. Ed. 2. 182 (1824). *Alsine borealis,* (Bigel.) Britton.

Infrequent; Centennial Valley, August 18, 1895 (No. 1738).

Stellaria longifolia, Muhl. Willd. Enum. 479. *Alsine longifolia,* (Muhl) Britton.

Abundant in wet places along streams; near Table Mountain, July 2, 1895 (No. 1417).

Stellaria longifolia laeta, T. & G. Bibl. Index. 112.

Rare; observed but once, LaPlata Mines, August 21, 1895 (No. 1774).

Stellaria longipes, Goldie, Edinb. Phil. Journ. vi, 327. *Alsine longipes,* (Goldie) Coville.

The commonest of the Chickweeds in Wyoming. Horse Creek, July 11, 1891, B. C. Buffum; Laramie, June 30, 1894 (No. 286). Lander, August 4, 1894 (No. 713).

Stellaria umbellata, Turcz. Cat. Baic. 5.

Frequent in the Mountains at 9,000 to 11,000 ft.; Union Pass, August 13, 1894 (No. 992); LaPlata Mines, August 21, 1895 (No. 1809).

Arenaria congesta, Nutt. T. & G. Fl. i, 178.

In open and in grassy places on hills and in the mountains everywhere; immensely abundant; Little Bald Mountain, August 15, 1892, B. C. Buffum; Laramie Hills, July 7, 1894 (No. 357).

Arenaria congesta subcongesta, Watson, Bot. Cal. i, 60.

Infrequent; only at high altitudes; on the Grand Teton, at 10,000 ft., August 21, 1894 (No. 1059).

Arenaria Fendleri, Gray, Pl. Fendl. 13.

This, like *A. congesta,* is found everywhere in the hills and mountains, in dry open rather than shaded ground. Laramie Hills, July 7, 1894 (No. 353).

Arenaria Hookeri, Nutt. T. & G. Fl. N. A. i, 178 (1838).

This is of very frequent occurrence both on the plains and in the mountains. Somewhat variable in general appearance; that on the plains short and forming large mats; that in the hills growing

in the Pine needles in the shade less, cæspitose and of ranker growth. Laramie, June 20, 1894 (No. 225); Wind River Mountains, August 11, 1894 (No. 856); Laramie Peak, August 7, 1895 (No. 1595).

Arenaria Sajanensis, Willd. Schlecht. Berl. Mag. Natf. 200 (1816).

This plant collected at almost the opposite extremes of the state seems to confine itself to the naked alpine summits. Union Peak, August 13, 1894 (No. 1009); La Plata Mines, August 22, 1895 (No. 1826).

Arenaria sp. (See appendix).

Tissa sparsiflora, Greene, Erythea, iii, (1895).

This recently described species seems to have a very circumscribed range. It was first observed in the autumn of 1894, when it was collected by the writer in a wet meadow, some seven miles from Laramie, in a soil strong with alkali, receiving seepage water from an irrigation ditch. A very rank growth, resulting in long, lax and sparsely flowered stems had been attained. Observations upon it in 1895 in the same and other localities show that, under normal conditions, it grows to only 3-8 inches in height; that it is nearly erect, but freely branched from the base. This shortening of the stems shows the flowers to be numerous in proportion to the size of the plant and makes the specific name hardly characteristic. In the original description the observation is made that it is the first Tissa reported from the interior of the continent. Observed only about Laramie and in low alkali ground. Seven Mile Lake, October 15, 1894 (No. 1158); Laramie, September 3, 1895 (No. 1868).

PORTULACACEÆ.

Portulaca oleracea, L. Sp. Pl. 445 (1753).

Becoming introduced in some localities; from Sheridan Expt. Farm, by the superintendent, J. F. Lewis, September 1895.

Calandrinia pygmæa, Gray, Proc. Am. Acad. viii, 623.

A beautiful little plant of alpine habitat. Union Peak, August 13, 1894 (No. 1015); La Plata Mines, August 20, 1895 (No. 1778).

Claytonia Caroliniana sessilifolia, Torr. Pac. R. Rep. iv, 70 (1856).

Common on hillsides in rich, damp soil. Laramie Hills, May 12, 1894 (No. 27); Pole Creek, May 18, 1895 (No. 1219).

Claytonia sp.?

This may be a reduced alpine form of the preceding. The whole plant is small, 1-2 inches high, raceme reduced to one or two flowers and the leaves more acutely lanceolate. Collected on the shores of a lake at 9,000 ft. on the Grand Teton, August 21, 1894 (No. 1061).

Claytonia Chamissonis, Esch. & Spreng. Syst. i, 790 (1825).

Not of frequent occurrence, but sometimes growing in the greatest profusion on the rocky beds of slow-flowing brooklets; Sybille Creek, July 8, 1894 (No. 309); Pole Creek, June 30, 1895 (No. 1337).

Lewisia rediviva, Pursh, Fl. ii, 368 (1814).

Comparatively rare, but occurring occasionally in profusion among the sage brush on the plains, and sometimes in the pine needles of rather open woods in the foothills. Sweetwater River, June 22, 1891, D. McLaren; Garfield Peak, July 29, 1894 (No. 679); Cummins, July 27, 1895 (No. 1545).

HYPERICACEÆ.

Hypericum Scouleri, Hook. Fl. Bor. Am. i, 111 (1830). *H. formosum Scouleri*, (Hook.) Coult.

Quite rare; in thickets along streams. Sybille Creek, July 8, 1894 (No. 341).

MALVACEÆ.

Sidalcea candida, Gray, Pl. Fendl. 20 and 24.

Frequent and abundant in thickets along streams in the mountains at 8,000-9,000 ft. Centennial Valley, September 8, 1891, B. C. Buffum; Cummins, July 31, 1895 (No. 1489).

Sidalcea malvæflora, Gray, Pl. Wright. i, 16 (1852).

Habitat and localities similar to those of the preceding; possibly of more frequent occurrence, the two species sometimes growing together. Saratoga, July 2, 1893, J. D. Parker; Cummins, July 28, 1895 (No. 1463).

Malvastrum coccineum, Gray, Mem. Am. Acad. iv, 21 (1848).

A common weed on the plains, in fields and fence corners. University Campus, June 22, 1894 (No. 280).

Sphæralcea acerifolia, Nutt. T. & G. Fl. N. A. i, 228 (1838).
Not abundant but widely distributed; in open woods at 8,000-9,000 ft. Union Pass, August 10, 1894 (No. 873); Centennial Valley, August 17, 1895 (No. 1727).

Sphæralcea Munroana, Spach. Proc. Am. Acad. xxii, 292 (1887).
Laramie, September 1, 1893; Sheridan Experiment Farm, September 1895.

LINACEÆ.

Linum Kingii, Watson, King Rep. v, 49 (1871).
A few specimens of this species were secured by Prof Buffum in 1892, but without data; probably collected late in June, near Elk Mountain.

Linum perenne, L. Sp. Pl. 277 (1753). *L. Lewisii,* Pursh.
Remarkably abundant and luxuriant throughout the state. Found on dry, rocky ridges as well as on rich hillsides and valleys. The valley of Bacon Creek in August presents the appearance of a flax field. Laramie, June 12, 1894 (No. 241); Union Pass and Bacon Creek, August 1894 (No. 866).

Linum rigidum, Pursh, Fl. Am. Sept. 210 (1814).
Common in the eastern part of the state. Inyan Kara Divide, August 29, 1892, B. C. Buffum; Wheatland, July 9, 1894 (No. 384).

GERANIACEÆ.

Geranium cæspitosum, James, Long's Exped. ii, 3.
Very frequent in the Laramie Hills, growing in scattered clumps on rocky ridges. By B. C. Buffum in 1892; Telephone Canon, June 15, 1894 (No. 233).

Geranium Fremonti, Torr. Gray, Pl. Fendl. 26.
Rare, observed but once; Union Pass, August 11, 1894 (No. 824).

Geranium Richardsoni, Fisch. Mey. Ind. Sem. Petr. iv, 37.
Frequent in the south-eastern part of the state at least; along streams and in damp thickets. Pole Creek, June 2, 1894 (No. 132); near Table Mountain, July 1, 1895 (No. 1403).

Oxalis stricta, L. Sp. Pl. 281 (1753).
This is the only species so far found in the state and this but once. Whalen Canon, July 18, 1894 (No. 522).

CELASTRACEÆ.

Pachystima Myrsinites, Raf. Am. Month. Mag. 176 (1819).

Occurring on the sides of wooded mountains. Tetons, August 22, 1894 (No. 977), at 7,500 ft.

RHAMNACEÆ.

Ceanothus Fendleri, Gray Pl. Fendl. 29 (1849).

Very rare, a single clump of it in an open valley, Laramie Peak, August 8, 1895 (No. 1637.)

Ceanothus velutinus, Dougl. Hook. Fl. Bor. Am. i, 125 (1830).

Presumably throughout the state; dry cañon-sides; Beaver Creek by B. C. Buffum, July 17, 1892; Tetons, August 21, 1894 (No. 948); Cummins, July 31, 1895 (No. 1542).

VITACEÆ.

Vitis riparia, Michx. Fl. ii, 231. *Wild Grape.*

This was collected in fruit not yet ripe, in one locality only; on the banks of the Platte River, Fairbanks, July 14, 1894 (No. 468).

Ampelopsis quinquefolia, Michx. Fl. Bor. Am. i, 160 (1803) *Parthenocissus quinquefolia,* (L.) Planch.

Quite rare in the state, possibly not found in the more elevated districts at all. Hartville, July 16, 1894 (No. 554).

SAPINDACEÆ.

Acer glabrum, Torr. Ann. Lyc. N. Y. ii, 172 (1826).

A common shrub on rocky hillsides and in the canons. Telephone Canon, May 23, 1894 (No. 57); Laramie Hills May 25, 1895 (No. 1236). *Maple.*

Negundo aceroides, Moench. Meth. 334 (1794). *Acer Negundo,* L.

Occurring occasionally along streams. Introduced at Laramie for shade and decorative purposes. June 1, 1894 (No. 183); Big Muddy Creek, July 26, 1894 (No. 611). *Box Elder.*

ANACARDIACEÆ.

Rhus toxicodendron, L. Sp. Pl. (1753). *Rhus radicans,* L.

Ours is the low erect form. Among rocks in canons at 5,000-6,000 ft. Table Mountain, June 2, 1894 (No. 154); Hartville, July

16, 1894 (No. 557); noted also at Laramie Peak, growing in profusion in a rocky canon. *Poison Ivy.*

Rhus trilobata, Nutt. T. & G. Fl. i, 219 (1838).

A low, spreading shrub, frequently almost covering both sides and summits of the low rounded hills in the Laramie range. Table Mountain, June 2, 1894 (No. 159); Blue Grass Hills, July 8, 1894 (No. 322); Laramie Peak, August 7, 1895 (No. 1477).

LEGUMINOSÆ.

Thermopsis montana, Nutt. T. & G. Fl. i, 388 (1838).

Not common, occurring on sandy creek banks. Laramie River, fl. June 15, fr. August 19, 1891, B. C. Buffum.

Thermopsis rhombifolia, Richards. App. Frank. Journ. 13 (1823).

Abundant in sandy ravines and valleys in the hills, the great patches of yellow standing out in sharp contrast to the green grass and white rocks. Table Mountain, June 2, 1894 (No. 122); Laramie Hills, June 5, 1895 (No. 1240).

Lupinus argenteus, Pursh, Fl. 468 (1814).

A widely distributed and common species of this well represented and beautiful genus. Apparently at higher altitudes than the var. following. Chugwater Creek, July 7, 1894 (No. 301); Meadow Creek, August 9, 1894 (No. 972); Laramie Peak, August 7, 1895 (No. 1584).

Lupinus argenteus decumbens, Wats. Proc. Am. Acad. xviii, 532 (1873).

On creek banks in the hills and plains. Pole Creek, June 2, 1894 (No. 104).

Lupinus aridus, Dougl. Lindl. Bot. Reg. xv, 1242 (1829).

On the plains of the Sweetwater River, by Geo. M. Cordiner, September 6, 1894 (No. 1206).

Lupinus cæspitosus, Nutt. T. & G. Fl. i, 379.

A delicate little plant almost alpine in its habitat; observed but once; Union Peak, August 13, 1894 (No. 996).

Lupinus laxiflorus, Dougl. Lindl. Bot. Reg. xiv, 1140 (1828).

Frequent and sometimes covering great stretches of the sandy plain with its characteristic color. Blue Grass Creek, July 8, 1894 (No. 360); Lusk, July 21, 1894 (No. 584); also west slope of Wind River Mountains, August 14, 1894.

Lupinus leucophyllus, Dougl. Lindl. Bot. Reg. xiii, 1124 (1828).

Our earliest Lupine, found in great profusion on moist hillsides among the sage brush and even in shaded localities. Laramie Hills, June 2, 1894 (No. 151).

Lupinus ornatus, Dougl. Lindl. Bot. Reg. xv, 1216 (1829).

Certainly deserving its name; abundant in the locality noted; Gros Ventre River, August 16, 1894 (No. 1098).

Lupinus parviflorus, Nutt. Hook. & Arn. Bot. Beechy, 336.

Common along streams; Sybille Creek, August 8, 1894 (No. 315); Table Mountain, July 1, 1895 (No. 1414).

Lupinus Plattensis, Wats. Proc. Am. Acad. xvii, 124 (1890).

This rare and beautiful plant was observed in two localities only. Mexican Mines, July 20, 1894 (No. 589); Pole Creek, near Table Mountain, July 1, 1895 (No. 1401).

Lupinus pusillus, Pursh, Fl. Am. Sept. 468 (1814).

Found only on the sand ridges and dunes occurring occasionally on the plains of eastern Wyoming. Platte River, July 14, 1894 (No. 490); noted also south of Lusk.

Lupinus Sitgreavesii, Wats. Proc. Am. Acad. xiii, 527.

Occurs only at comparatively high altitudes in wooded mountains. Union Pass, August 12, 1894 (No. 896); frequent at 9,000 ft. and upward.

Medicago sativa, L. Sp. Pl. 778 (1753). *Lucerne, Alfalfa;* largely grown as a forage plant in the west; escaped from cultivation. Laramie, September 9, 1894 (No. 1136).

Melilotus alba, Lam. Encycl. iv, 63 (1797). *Sweet Clover.*

Persisting in fallow or abandoned fields. Laramie, October 2, 1894 (No. 1154.)

Melilotus officinalis, (L.) Lam. Fl. France, ii, 594 (1778).

Introduced and then persisting in abandoned areas for a number of years, possibly indefinitely. Laramie, June 23, 1895 (No. 1422).

Psoralea argophylla, Pursh, Fl. Am. Sept. 475 (1814).

Noted a number of times in eastern Wyoming; Platte River, July 14, 1894 (No. 497); from Inyan Kara Divide by B. C. Buffum, 1892, and from Sheridan by J. F. Lewis, 1895.

Psoralea lanceolata, Pursh, l. c.

Frequent on the dry foothills along the Platte River. Fairbanks, July 12, 1894 (No. 430); Orin Junction, August 14, 1892, B. C. Buffum.

Psoralea tenuiflora, Pursh, l. c.

Our commonest Psoralea, very abundant along the Platte and its tributaries. Laramie River, July 10, 1894 (No. 368); Blue Grass Creek, July 8, 1894 (No. 306),

Trifolium dasyphyllum, T. & G. Fl. N. A. i, 315.

This fine cæspitose species almost clothes some of the otherwise naked rocky ledges in the Laramie foothills. Some specimens secured at Laramie Peak are quite erect with longer and less pubescent leaves. Laramie, May 25, 1894 (No. 68); June 5, 1895 (No. 1243).

Trifolium gymnocarpon, Nutt. T. & G. Fl. i, 320.

A rare and inconspicuous little plant, blossoming in late spring and shortly disappearing. Laramie, June 9, 1894 (No. 216); Experiment Farm, May 23, 1895 (No. 1230).

Trifolium longipes, Nutt. T. & G. Fl. i, 314 and 691.

Frequent in the mountains at 8,000-9,000 ft. Specimens from Saratoga and Bald Mountain; also Union Pass, August 13; 1895 (No. 1025).

Trifolium longipes reflexum, n. var.

This has the general habit of *T. longipes* but the flowers are at length quite reflexed; calyx lobes shorter and less villous. On the banks of Wind River at the foot of Union Pass, August 9, 1894 (No. 918).

Trifolium Parryi, Gray, Am. Journ. Sci. ii, 33.

Rare, in open spruce woods, Medicine Bow Mountains, August 21, 1895 (No. 1764).

Trifolium pratense, L. Sp. Pl. 768 (1753). *Red Clover.*

Trifolium repens, L. Sp. Pl. 767 (1753).

This and the preceding becoming naturalized along irrigation ditches, in the streets and elsewhere. Laramie, September 15, 1894. *White Clover.*

Amorpha fruiticosa, L. Sp. Pl. 713 (1753).

Frequent on the banks of the Platte in the eastern part of the state. Fairbanks, July 13, 1894 (No. 438).

Dalea aurea, Nutt. Fras. Cat. (1813). *Parosela aurea*, (Nutt.) Britton.
Very rare; on the plains of the Platte; Fairbanks, July 11, 1894 (No. 390).

Petalostemon candidus, Michx. Fl. Bor. Am. ii, 49 (1803). *Kuhnistera candida*, (Willd.) Kuntze.
Occasional, on the dry hills and plains bordering on the Platte. Orin Junction, August 14, 1891, B. C. Buffum.

Petalostemon multiflorus, Nutt. Journ. Phil. Acad. vii, 92 (1834).
This seems to be a much-named plant and illustrates nicely the stability that our nomenclature is acquiring. The new Check List gives *Kuhnistera multiflora*, (Nutt.) Heller, and, if I understand Mr. Rydberg rightly, his new name, *Kuhnistera, candida multiflora*, (Nutt.), Contrib. Nat'l Herb. iii, 3. (1895), is also the same. From the specimens at hand I am inclined to think that Mr. Rydberg is right in reducing the form to a variety. On the other hand his variety *occidentalis* does not seem to differ in any important respect from his *multiflora*, judging by his descriptions. Some specimens at hand will fall nicely under either.

Very frequent in the Laramie Hills and the foothills bordering on the Platte. July 9, 1894 (No. 330); Inyan Kara Divide by B. C. Buffum.

Petalostemon violaceus, Michx. Fl. Bor. Am. ii, 50 (1803). *Kuhnistera purpurea*, (Vent.) MacM.
Habitat and localities much the same as for the preceding. Orin Junction, July 14, 1891, B. C. Buffum; Platte Hills, July 9, 1894 (No. 331).

Astragalus adsurgens, Pall. Astrag. 40, t, 31 (1800). *A. Laxmanni*, Jacq.
Remarkably abundant in the south-eastern part of the state, occupying dry, stony or gravelly ridges on the plains or in the foothills.

Wallace Creek, July 29, 1894 (No. 646); Cummins, July 30, 1895 (No. 1514); at Laramie at various times.

Astragalus alpinus, L. Sp. Pl. 760 (1753).
Probably frequent in the higher mountain valleys; Pole Creek, June 3, 1894 (No. 174); Union Pass, August 11, 1894 (No. 840). Unusually large specimens with leaves varying from elliptical to obcordate were obtained on Union Peak, August 13, 1894 (No. 993).

Astragalus bisulcatus, Gray, Pac. R. Rep. xii, 42 (1860.)

A very common species on the plains and in the foothills; Laramie, June 19, 1894 (No. 266); Garfield Peak, July 29, 1895 (No. 682); other numbers are 1316 and 1435.

Astragalus Canadensis, L. Sp. Pl. 757 (1753). *A. Carolinianus,* L.

Possibly confined to the eastern part of the state.

Lusk, July 21, 1894 (No. 582); Laramie Peak, August 7, 1895 (No. 1597).

Astragalus caryocarpus, Ker. Bot. Reg. t, 176 (1816). *A. crassicarpus,* Nutt.

Infrequent; on the Laramie plains and on the east slopes of the Laramie range. Pole Creek, June 2, 1894 (No. 162); Laramie, June 25, 1894 (No. 201).

Astragalus convalarius, Greene.

I am unable to cite the publication of this; the name was communicated by Prof. Sheldon; probably rare; Union Pass, August 10, 1894 (Nos. 743 and 869).

Astragalus Drummondii, Dougl. Hook. Fl. Bor. Am. i, 153 (1833).

Frequent in the foothills throughout the state; Pole Creek, June 2, 1894 (No. 86); Upper Wind River, August 10, 1894 (No. 763).

Astragalus flexuosus, Dougl., in Don. Gen. Syst. Gard. and Bot. ii, 256 (1832).

On wet, fertile creek banks; Chugwater, July 7, 1894 (No. 422); Pole Creek, July 1, 1895 (No. 1352).

Astragalus frigidus Americanus, Watson, Index, i, 193.

Very rare; South Fork, Crazy Woman Creek, August 7, 1892, B. C. Buffum.

Astragalus giganteus, Sheld. Bull. Minn. Geol. and Nat. Hist. Surv. ix. 65 (894).

Infrequent; Bald Mountain, August 15, 1892; Green River, August 26, 1894 (No. 1047).

Astragalus hypoglottis, L. Mant. ii, 274 (1771).

Frequent and abundant in wet meadows and along streams in our whole range. Saratoga, July 6, 1891; Meadow Creek, August 9, 1894 (No. 815). Fine specimens with ohroleucus flowers were obtained at Meadow Creek, August 9, 1894 (No. 775).

Astragalus Kentrophyta, Gray, Proc. Acad. Philad. 60 (1863).

Probably belonging to the Pacific slopes alone; on the banks of the Gros Ventre River, August 16, 1894 (No. 1077).

Astragalus junceus, Gray, Proc. Am. Acad. vi, 230.

Infrequent; on steep, dry stony hillsides; Saratoga, June 23, 1893; Gros Ventre River, August 17, 1894 (No. 1086).

Astragalus lonchocarpus, Torr. Pac. R. Pep. iv, 80.

What appears to be of this species was collected on Snake River, May 29, 1892, by Fred McCoullough.

Astragalus Missouriensis, Nutt. Gen. ii, 99 (1818).

Abundant on the Laramie plains but in the foothills giving place to *A. Shortianus.* Laramie, May 22, 1894 (No. 52); also in 1895 (No. 1227).

Astragalus Mortoni, Nutt. Journ. Acad. Phila. vii, 19 (1834).

On the Pacific slope only, infrequent; Gros Ventre River, August 16, 1894 (No. 1080).

Astragalus oroboides Americanus, Gray, Proc. Am. Acad. vi, 205 (1864). *A. oroboides,* Hornem.

Infrequent; Bacon Creek, August 15, 1894 (No. 917).

Astragalus pectinatus, Dougl. in Don. Gen. Syst. Gard. and Bot. ii, 257 (1832).

Frequent and abundant on the Laramie Plains; June 12, 1894 (No. 217).

Some forms of it seem to approach *A. Grayi* so closely as to make it difficult to know where to place them, such as my number 1304 from Centennial Valley, June 9, 1895.

Astragalus Purshii, Dougl. Hook. Fl. Bor. Am. i, 152 (1834).

Of frequent occurrence, but the plants few and scattering.

On the Laramie Plains, May 23, 1894 (No. 53); May, 1895 (No. 1228).

Astragalus sericoleucus, Gray, Am. Jour. Sci. II, xxxiii, 410 (1862).

Frequent on the plains and in the foothills, where it clothes the otherwise naked ground as with a purple carpet.

Laramie, May 18, 1894 (No. 38).

Astragalus Shortianus, Nutt. T. & G. Fl. N. A i, 331 (1838).

On gravelly, stony hillsides; frequent in the Laramie range.

Telephone Canon, May 23, 1894 (No. 54); Centennial Valley, June 9, 1895 (No. 1286).

Astragalus spatulatus, Sheld. Bull. Minn. Geol. & Nat. Hist. Surv. ix, 19 (1894).

Very abundant both on the plains and in the foothills.

Laramie Hills, May 16, 1894 (No. 31); Centennial Valley, June 9, 1895 (No, 1301); also a white flowered variety from the latter place.

Astragalus tenellus, Pursh, Fl. Am. Sept. 473 (1814).

Seemingly throughout the state, in dry, sandy soil.

Laramie, June 19, 1894 (No. 267); Dubois, August 9, 1894 (No. 751); Cummins, July 26, 1895 (No. 1432).

Astragalus. (For other numbers see appendix).

Oxytropis deflexa, D C. Prodr. ii ,280.

Infrequent, in mountain Meadows, at 7,000-8,000 ft.; Union Pass, August 11, 1894 (No. 825); Laramie Peak, August 8, 1895 (No. 1530).

Oxytropis Lamberti, Pursh, Fl. Am. Sept. 740 (1814). *Spiesia Lamberti*, (Pursh) Kuntze.

The typical form is not frequent. As far as my observation goes, it is confined to the eastern part of the state. By the typical form is meant the purple-flowered form described in our manuals under this name. Table Mountain, July 1, 1895 (No. 1320).

Oxytropis Lamberti sericea, Nutt. T. & G. i, 339 (1838). *Spiesia Lamberti sericea*, (Nutt.) Rydberg.

Very rare; Laramie, 1893. Flowers violet.

Oxytropis (Spiesia) Lamberti ochroleuca, n. var.

Stout, grayish, with a close pubescence throughout; very many short stems from the large perennial root, each of which bears one to several long scape-like peduncles; flowers yellowish-white with sometimes a purple spot on the keel petals.

This is the frequently mentioned ochroleucus flowered form of this species, but it certainly, with us at least, forms a good and constant variety, if not species. It can always be distinguished by its stouter habit throughout, by the densely lanate scale-like stipules, by the shorter but thicker spike as well as by the very numerous and crowded stems and scapes. Exceedingly abundant; Pole Creek, June 2, 1894 (No. 119); Laramie, June 9, 1895 (No. 1302). *Loco.*

Oxytropis monticola, Gray. Proc. Am. Acad. xx, 6.

Frequent in the vicinity of Laramie; May 23, 1894 (No. 60); June 9, 1895 (No. 1294).

Oxytropis multiceps, Nutt. T. & G. Fl. i, 341 (1838). *Spiesia multiceps,* (Nutt.) Kuntze.

Very rare; on a hilltop of disintegrated granite, near Horse Creek, June 9, 1894 (No. 214).

Oxytropis splendens, Dougl. Hook. Fl. Bor. Am. i, 147 (1833). *Spiesia splendens,* (Dougl.) Kuntze.

This truly splendid species is not rare in the grassy valleys at about 7,000-8,000 ft. and sometimes at lower altitudes. Table Mountain, July 2, 1895 (No. 1391); Cummins July 29, 1895.

Oxytropis sp. ? (Nos 669 and 928, see appendix).

Glyceria lepidota, Pursh, Fl. Am. Sept. 480 (1814).

Frequent near the Platte on the banks of small ditches and ravines. Willow Creek, July 22, 1894 (No. 627); Cheyenne, August 29, 1893.

Hedysarum boreale, Nutt. Gen. ii, 110 (1818). *H. Americanum,* (Michx.) Britton.

Probably infrequent except northward; Union Pass, August 10, 1894 (No. 877).

Hedysarum Mackenzii, Richards, App. Frank. Journ. 17 (1823). *H. Americanum Mackenzii,* (Richards.) Britton.

Throughout the state; Crazy Woman Creek, August 7, 1892; Dubois, August 9, 1894 (No. 752); Snake River, August 19, 1894 (No. 1087).

Vicia Americana, Muhl. Willd. Sp. Pl. ii, 1096 (1803).

Of frequent occurrence in thickets on stream banks. Cummins, July 29, 1895, two forms of it, (Nos. 1450 and 1478).

Vicia Americana truncata, Brewer, Bot. Cal. i, 158 (1876).

More frequent than the species; Wheatland, August 1892, B. C. Buffum; Table Mountain, June 30, 1895 (No. 1404).

Vicia linearis, (Nutt.) Greene, Fl. Fran. 3 (1891).

Especially abundant; on sandy plains and creek valleys everywhere.

Pole Creek, June 2, 1894 (No. 92); Laramie, June 1, 1894 (No. 172); Meadow Creek, August 9, 1894 (No. 776).

Vicia cracca, L. Sp. Pl. 735 (1753).

A chance introduction on the Laramie Experiment Farm, September 1895.

Lathyrus ornatus, Nutt. T. & G. Fl. N. A. i, 277 (1838).

Members of this genus are either very rare or the right localities have not yet been visited. A specimen in the herbarium from Cheyenne, by Miss Helen Furniss, June 1892.

ROSACEÆ.

Prunus Americana, Marsh, Arb. Am. 111 (1785).

Rare in the southeastern part of the state and probably infrequent everywhere except in the lower altitudes of the northeastern part, where it is reported very plentiful.

Fairbanks, July 18, 1894 (No. 572). *Wild Plum.*

Prunus demissa, Walp. Rep. ii, 10 (1843).

This and the succeeding species have so much in common that it is difficult to separate them. It may be that none of the specimens are *P. Virginiana*, but rather only forms of *P. demissa*. Common on dry creek banks in the hills.

Telephone Canon, June 15, 1894 (No. 230); Table Mountain, June 30, 1895 (No. 1402). *Wild Cherry, Choke Cherry.*

Prunus Virginiana, L. Sp. Pl. 473 (1753).

Teton Mountains, August 21, 1894 (No. 943), and by B. C. Buffum, 1892.

Spirea arbuscula, Greene, Erythea, iii, 63 (1895).

Infrequent and, I think, found only at high elevations, 8,000 ft. and upward.

Teton Mountains, August 21, 1894 (No. 941).

Spirea discolor dumosa, Watson, Pursh Fl. 342 (1814).

A handsome shrub, common on rocky ledges at 8,000 ft. and upward.

Casper Mountain, July 26, 1894 (No. 607); Garfield Peak, July 29, 1894 (No. 657); also observed at Laramte Peak and in the Medicine Bow Mountains in 1895.

Spirea lucida, Dougl.

Very rare in the state.

Teton Mountains, August 21, 1894 (No. 949).

Physocarpus Torreyi, Maxim. *Neillia Torreyi,* Watson, Proc. Am. Acad. xi, 136.

Common in the hills and mountains.

Table Mountain, June 2, 1894 (No. 116); Platte River, July 14, 1894 (No. 490).

Rubus Nutkanus, Mocino, Lindl. Bot. Reg. t. 1368 (1830).

Not common in the parts of the state collected.

Teton Mountains, August 21, 1894, and Centennial Hills, August 18, 1895 (No. 1676). *Thimble-berry.*

Rubus strigosus, Michx. Fl. i, 297 (1803).

The *Red Raspberry,* growing in the greatest profusion on rocky and partially wooded hillsides, especially on ground once burned over. Immensely productive.

Union Peak, August 13, 1894 (No. 997). Cummins, July 31 1895 (No. 1476).

Purshia tridentata,, D C. Trans. Linn. Soc. 12, 157.

A scragly prostrate shrub, common on low hilltops and hillsides.

Pole Creek, June 2, 1894 (No. 82); Wallace Creek, July 29, 1894 (No. 676); Centennial Valley, June 9, 1895 (No. 1270),

Cercocarpus parvifolius, H. & A. Bot. Beechey, 337 (1841).

This may be called the most characteristic shrub of stony foothills.

Laramie Hills, June 15, 1894 (No. 237); Platte Hills, July 14, 1894 (No. 462). *Mountain Mahogany.*

Geum macrophyllum, Willd. Enum. i, 557 (1809).

Mr. Rydberg* suggests the probability that this and the following are varieties of the same species. The specimens before me, however, seem perfectly distinct. Near streams.

Bacon Creek, August 15, 1894 (No. 920); Cummins, July 30, 1895 (No. 1576).

Geum strictum, Ait. Hort. Kew. ii, 217 (1789).

Same habitat as the preceding.

Sybille Creek, July 8, 1894 (No. 407); Cummins, July 30, 1895 (No. 1517).

Geum triflorum, Pursh, Fl. 736 (1814).

This fine species is common in wet valleys at 7,000-9,000 ft. Our manuals fail to note that the style is jointed in the middle in young

*Contrib. Natl. Herb. iii, 3, 157 (1895).

specimens, but as the apical portion is early deciduous it appears perfectly straight in maturer blossoms.

Union Pass, August 11, 1894 (No. 829); Saw Mill Creek, May 25, 1895 (No. 1258).

Fragaria vesca Americana, Porter, Bull. Torr. Bot. Club, xvii, 15 (1890).

In mountain meadows and valleys, in parks and on wet hillsides everywhere. Sometimes fruiting abundantly, the berries small but sweet.

Horse Creek, June 9, 1894 (No. 207). *Strawberry.*

Fragaria Virginiana Illinœnsis, Prince, Gray Man Ed. 5, 155 (1867).

This species is rare, at least about Laramie, but specimens collected by A. H. Danielson near Jelm Mountain, May, 1895, seem to be of this form (No. 1209).

Potentilla anserina, L. Sp. Pl. 495 (1753).

Common in wet soils, especially near slightly alkali marshes. Laramie all summer.

Collected on Green River, August 26, 1894 (No. 1039).

Potentilla arguta, Pursh, Fl. Am. Sept. 736 (1814).

Forming immense yellow patches among the rocks in the hills. A fine plant.

Pole Creek Hills, June 2, 1894 (No. 95); June 30, 1895 (No. 1351).

Potentilla dissecta, Pursh, Fl. Am. Sept. (1814).

This fine species is probably confined to high elevations.

Teton Mountains, August 22, 1894 (No. 970); LaPlata Mines, August 20, 1895 (No. 1773).

Potentilla fruticosa, L. Sp. Pl. 495 (1753).

Common on the banks of mountain streams.

Wind River, August 9, 1894 (No. 748); Little Sandy, August 30, 1894 (No. 1127).

Potentilla glandulosa, Lindl. Bot. Reg. xix, t. 1583 (1833).

Occasional along streams in sandy loam.

Union Pass, August 12, 1894 (No. 867); Cummins, July 30, 1895 (No. 1493).

Potentilla gracilis, Dougl. Hook. Bot. Mag. (1830).

This is a most polymorphous species, the forms of it differing strikingly as to tomentum, hirsuteness, leaf margin, etc. It seems

probable that a careful examination will show at least some varieties which ought to be separated from the species. In wet meadows and along mountain streams.

Laramie River, July 9, 1894 (No. 325); Wallace Creek, July 29, 1894 (No. 665); Wind River Mountains, August 13, 1894 (No. 931); Table Mountain, June 30, 1895 (No. 1347); La Plata Mines, August 21, 1895 (No. 1821).

Potentilla gracilis fastigiata, Watson, Proc. Am. Acad. viii, 557 (1873).

Union Pass, August 13, 1894 (No. 990); Centennial Valley, August 25, 1895 (No. 1858).

Potentilla gracilis flabelliformis, Torr. & Gray, Fl. (1838).

A rare and beautiful plant, the deeply pinnatifid leaflets densely white tomentose on the lower surface.

Meadow Creek, August 9, 1894 (No. 786).

Potentilla Hippiana, Lehm. Nov. Stirp. Pug. ii, 197 (1830).

Very common on rocky slopes and hills.

Laramie Hills, July 7, 1894 (No. 410); Garfield Peak, July 29, (No. 651); Table Mountain, June 29, 1895 (No. 1368).

Potentilla Hippiana pulcherrima, Watson, Proc. Am. Acad. viii, 555 (1873). *Potentilla pulcherrima*, Lehm.

This is not common, and seems to have affinities with *P. gracilis*, *P. Pennsylvanica* and *P. Hippiana*.

La Plata Mines, August 22, 1895 (No. 1789).

Potentilla humifusa, Nutt. Gen. i, 330 (1818).

Common early in the year on gravelly hillsides.

Laramie Hills, June 2, 1894 (No. 99); May 18, 1895 (No. 1216).

Potentilla Norvegica, L. Sp. Pl. 499 (1753). *P. Monspeliensis*, L.

Apparently throughout the state.

Platte River and Willow Creek, July 1894 (Nos. 502 and 565); Laramie, September 16, 1894 (No. 1143); Cummins, July 30, 1895 (No. 1474).

Potentilla Pennsylvanica, L. Mant. 76 (1767).

Observed but once.

Bessemer, on the Platte River, July 26, 1894 (No. 612).

Potentilla Pennsylvanica strigosa, Pursh, Fl. Am. Sept. 356 (1814).

In rather dry valleys; more frequent than the species.

Whalen Canon, July 18, 1894 (No. 525); Cummins, July 30, 1895 (No. 1545).

Potentilla Plattensis, T. & G. Fl. i, 439 (1838).

On sandy flats bordering on streams.

Horse Creek, June 9, 1894 (No. 206); Laramie River, June 19, 1894 (No. 265).

Potentilla pinnatisecta, n. sp.

This form should not have been suppressed. In Watson's King's Report it appears as *P. diversifolia pinnatisecta*. The points upon which he based the variety are well taken but not strongly enough emphasized. The following, it seems to me, justify the separation of this form from *P. Plattensis* as a distinct species. *P. Plattensis* has been repeatedly observed but only on bottom lands near streams and, I think, thus far, with one exception,* only on streams tributary to the Platte. *P. pinnatisecta* is strictly alpine. The specimens before me were collected on the naked summits of the Medicine Bow Mountains, above timber line at about 11,500 feet, growing among the rocks in the most bleak and barren places.

The two differ markedly in habit as well as in habitat. *P. Plattensis* is decumbent at base, with branches diffuse or loosely spreading. *P. pinnatisecta*, while its branches are slightly decumbent at base, yet the plant as a whole may be spoken of as strictly erect. The cymes are more regular and more open. The leaves are longer, leaflets less crowded and inclined to be pedately parted rather than pinately, strictly cuneate at base. Leaves largely radical, those on the stem greatly reduced. Petioles and stems nearly glabrous with a brownish glaucus hue. Leaves glabrous on the upper surface, softly silky villous on the lower. The plant 5-8 inches high.

Potentilla supina, Michx. Fl. Bor. Am. i, 304 (1803). *P. paradoxa*, Nutt.

Not of frequent occurrence; Hartville, July 16, 1894 (No. 555); Cummins, July 28, 1895 (No. 1525).

Sibbaldia procumbens, L. Sp. Pl. 284 (1753).

Frequent at high altitudes, 10,000 ft. and upward. Union Peak, August 13, 1894 (No. 1010); La Plata Mines, August 23, 1895 (No. 1799).

*Bot. Death Valley Exped. Contrib. Natl. Herb. iv, 112 (1893.

Chamærhodos erecta, Bunge. Ledeb. Fl. Alt. i, 431.

Observed but once but then in the greatest abundance, on a sand-bar of the Laramie River, June 18, 1894 (No. 261).

Agrimonia Eupatoria, L. Walt. Fl. Car. 131 (1788). *A. Striata,* Michx.

Not at all common; Laramie Peak, on a wooded stream, August 9, 1895 (No. 1653).

Rosa acicularis, Lindl. Ros. Monog. 44, t. 8 (1820).

Found most frequently at the foot of dry, clayey creek banks.

Pole Creek, June 2, 1894 (No. 134); Centennial Valley, August 18, 1895 (No. 1697).

Rosa Arkansana, Porter, Syn. Fl. Col. 38 (1874).

A fine species often met with in wet ravines in the mountains.

Mexican Mines, July 20, 1894 (No. 567); Table Mountain, June 30, 1895 (No. 1336).

Rosa blanda, Ait. Hort. Kew. ii, 202 (1779).

Rather common in canons and the adjacent hillsides.

Whalen Canon, July 18, 1894 (No. 520); Table Mountain, June 30, 1895 (No. 1343).

Rosa Fendleri,.Crepin, Prim. Monog. Ros. 452 (1874).

Probably quite rare in the state,

Boulder Creek, August 27, 1894 (No. 1101).

Rosa Sayi, Schwein. Keating, Long's Exped. Appx. 113.

I note that recently this has been made a synonym for *R. acicularis*, but in Watson's Rev. Ros. N. A. 340 (1885), the two forms are kept distinct. If the two forms before me are correctly determined he is amply justified in doing so.

Table Mountain, June 30, 1895 (No. 1643). Also by B. C. Buffum, June 6, 1892.

Rosa Woodsii, Lindl. Ros. Monog. 21 (1820).

A small form, common, in the dry hills and sandy ravines, inclined to be prostrate.

Laramie Hills, June 12, 1894 (No. 242).

Pyrus sambucifolia, Cham. & Schlecht. Linnæa, ii, (1827). *Sorbus sambucifolia,* Roem.

Rather rare; Teton Mountains, August 22, 1894 (No. 982); also from the Centennial Valley, by B. C. Buffum.

Cratægus Douglasii, Lindl. Bot. Reg. 21, t, (1810).

Very scarce, only a few specimens observed in one locality. These are not typical, yet can hardly belong to the following species though approaching it more closely than any other.

Casper, July 25, 1894 (No. 606). *Hawthorn.*

Cratægus rivularis, Nutt. T. & G. Fl. i, 464 (1840).

Of rather frequent occurrence on some streams.

Gros Ventre River August 22, 1894 (No. 1066).

Amelanchier alnifolia, Nutt. Journ. Acad. Phila. viii, 22 (1834).

Very common in the foothills and along streams.

Telephone Canon, June 2, 1894 (No. 117).

Amelanchier pumila, Nutt. Roem. Syn. Monog. iii, 145.

Prof. E. L. Greene, of Catholic University, Washington, D. C., writes me that in 1893 I sent him some material as *A. alnifolia*, which, on examination, proves to be the long suppressed *A. pumila* of which he writes as follows: "It may be recognized by its being perfectly glabrous; by having much longer and narrower petals and by having its leaves serrate almost from base to apex, whereas *A. alnifolia* has its leaves serrate only from the middle upwards."

On examination of the material in our herbarium I find that our 1893 material answers to this description of *A. pumila* perfectly.

Laramie Hills, May 1893. *Service Berry.*

SAXIFRAGACEÆ.

Saxifraga bronchialis, L. Sp. Pl. i, 400 (1753).

Teton Mountains, at high elevations, August 21, 1894 (No. 976).

Saxifraga Jamesii, Torr. Ann. Lyc. N. Y. ii, 204.

This rare species was observed but once. Jackson's Hole, August 22, 1894 (No. 971).

Saxifraga integrifolia, Hook. Fl. Bor. Am. i, 249 (1834).

Grassy places in the mountains, but not at all common.

Bald Mountain, August 16, 1892, B. C. Buffum; Union Pass, August 10, 1894 (No. 930).

Saxifraga nivalis, L. Sp. Pl. i, 401 (1753).

This species is not strictly alpine if this idea be represented solely by altitude. Common, and blossoming in May at 7,000 ft., and successively throughout the season at higher and higher altitudes.

Wind River Mountains, July 20, 1892, B. C. Buffum; Pole Creek, June 2, 1894 (No. 127); La Plata Mines, August 22, 1895.

Saxifraga punctata, L. Sp. Pl. 401 (1753).

Frequent in wet, shaded ravines at high elevations.

Union Pass, August 12, 1894 (No. 843), also from Bald Mountain, by B. C. Buffum.

Saxifraga Virginiensis, Michx. Fl. Bor. Am. i, 269 (1803).

This is less common than *S. nivalis* which it closely resembles.

In the lower valleys of the state. Bald Mountain, August 15, 1892, by B. C. Buffum.

Tellima tenella, Walp. Rept. ii, 371 (1843).

Rare, on the sandy slopes of valleys.

Horse Creek, June 11, 1892; Bald Mountain, August 15, 1892, B. C. Buffum.

Mitella pentandra, Hook. Bot. Mag. lvi, t. 2933 (1829).

Frequent in damp ravines in the mountains.

Teton Mountains, August 21, 1894 (No. 944); Laramie Peak, August 8, 1895 (No. 1623).

Mitella trifida, Graham. var. **integripetala,** Rose.

This new variety is founded upon material collected by B. C. Buffum, and sent by myself to Dr. J. N. Rose, who named it and I suppose published it, but I am unable to cite the publication. It differs from the species mainly in its entire petals and its leaves, which are incisely dentate rather than crenate dentate. Certainly very rare.

Bald Mountain, August 15, 1892.

Heuchera parviflora, Nutt. T. & G. Fl. i, 581 (1838).

Very common on stony ridges and hillsides in the Laramie range.

Pole Creek, June 2, 1894 (No. 163); Table Mountain, June 28, 1895 (No. 1344); also observed in the Medicine Bow Mountains, August 1895.

Parnassia fimbriata, Banks, in Koenig & Sims, Ann. Bot. i, 391 (1805).

Along streams and in wet thickets at high altitudes.

Head of Green River, August 26, 1894 (No. 1034); La Plata Mines, August 22, 1895 (No. 1803).

Parnassia palustris, L. Sp. Pl. 273 (1753).

Quite rare and not readily distinguished from the next except by the cordate leaves.

Bald Mountain, August 16, 1892, B. C. Buffum.

Parnassia parviflora, D C. Prodr. i, 320.

Rather common on grassy stream banks almost in the water.

Fort Washakie, August 5, 1894 (No. 746).

Jamesia Americana, T. & G. Fl. i, 593 (1840).

A very handsome shrub when in blossom. Rare; in rocky canons.

From Saratoga by B. C. Buffum, June 1892; Table Mountain, July 1, 1895 (No. 1418).

Ribes aureum, Pursh, Fl. 164 (1814).

Common in the canons of the Platte, where the black fruited form seems to predominate. Introduced in Laramie as an ornamental shrub.

Fairbanks, July 18, 1894 (No. 571). *Missouri* or *Flowering Currant.*

Ribes aureum chrysococcus, Rydberg, Fl. Neb. xxi, 71 (1895).

Mr. Rydberg founds this variety upon the character of the fruit. It is what has been called the yellow fruited form of the preceding. Noted by Mr. Rydberg, it may again be stated that there is no discernible difference between the flowers and leaves of the two forms, but the fruits are strikingly different, and apparently the difference is constant. The variety is very common in the Platte canons at Fairbanks and produces large, finely flavored berries in abundance, which are gathered in large quantities for domestic use by the residents of the place.

Fairbanks, July 18, 1894 (No. 571a). *Yellow Currant.*

Ribes cereum, Dougl. Trans. Hort. Soc. Lond. vii, 512 (1830).

Exceedingly common on dry, rocky hillsides throughout the state.

Laramie Hills, May 16, 1894 (No. 30); May, 1895 (No. 1231).

Ribes divaricatum, Dougl. Trans. Hort. Soc. Lond. vii, 515 (1830).

Presumably rare; Union Pass, Aug. 10, 1894 (No. 862).

Ribes divaricatum irrigum, Gray, Am. Naturalist, x, 273.

Growing in great profusion in the copses bordering stream banks and producing an abundance of very acid but pleasantly flavored fruit.

Pole Creek, June 2, 1894 (No. 96). Observed in many other parts of the state, but the borders of Wallace Creek may be spoken of as one immense *Gooseberry* patch.

Ribes floridum, L'Her. Stirp. i, 4 (Ehrh. Beitr. vi. 119).

Observed but once; Whalen Canon, July 18, 1894 (No. 541).

Ribes lacustre, Poir. Encycl. Suppl. ii, 856 (1811).

Very common in copses on canon streams.

Teton Mountains, August 21, 1894 (No. 938); Centennial Valley, fls. June 9, 1895 (No. 1556); fr. August 17, 1895 (No. 1689).

Ribes lacustre parvulum, Gray, Bot. Cal. i, 206 (1876).

Frequent in wet thickets at subalpine stations.

Union Peak, August 13, 1894 (No. 1022); LaPlata Mines, August 23, 1895 (No. 1801).

Ribes lacustre molle, (?) Gray, Bot. Cal. i, 206 (1876).

My specimens are clearly a variety of *R. lacustre*, but as I have no description of this variety I put it here tentatively. It has larger fruits and is more softly pubescent than the species.

Union Pass, August 13, 1894 (No. 1073).

Ribes leptanthum, Gray, Pl. Fendl. 53 (1849).

This horridly prickly form must be very rare in the state for, though it is naturally conspicuous, I have observed it but once.

Garfield Peak, July 29, 1894 (No. 695).

Ribes oxyacanthoides, L. Sp. Pl. 201 (1753).

Collected only in one locality, and probably confined to the eastern part of the state.

Pole Creek, June 2, 1894 (No. 129).

Ribes oxyacanthoides saxosum, (Hook.) Coville, Contrib. Natl. Herb. iv, 100 (1893).

This I at first thought the same as the preceding, but on comparing my specimens with description, l. c., I find that they must be referred to this variety.

Bacon Creek, August 25, 1894 (No 1044).

Ribes sanguineum variegatum, Wats. Bot. King Surv. 100 (1871).

Union Pass, August 10, 1894 (No. 860).

CRASSULACEÆ.

Sedum Douglasii, Hook. Fl. Bor. Am. i, 228.

Rare; collected at Wheatland, June 11, 1891, B. C. Buffum.

Sedum rodanthum, Gray, Am. Journ Sci. ii, 33. 405.

In wet bogs in the mountains; subalpine.

Union Pass, August 13, 1894 (No. 929); La Plata Mines, August 23, 1895 (No. 1703).

Sedum stenopetalum, Pursh Fl. i, 324 (1814).

Exceedingly abundant on rocky slopes in the foothills.

Laramie Hills, July 7, 1894 (No. 351); Table Mountain, June 29, 1895 (No. 1467).

HALORAGEÆ.

Hippuris vulgaris, L. Sp. Pl. 4 (1753).

Not at all common; in a muddy bog in Lander, August 3, 1894 (No. 694).

Callitriche palustris, L. Sp. Pl. 969 (1753).

In shallow ponds and pools; rather frequent.

Near Green River, August 25, 1894 (No. 1102); Centennial Valley, August 25, 1895 (No. 1860).

Myriophyllum verticillatum, L. Sp. Pl. 992 (1753).

Green River, August 26, 1894 (No. 1038).

ONAGRACEÆ.

Epilobium adenocaulon, Hausskn. Oest. Bot. Zeitschr. xxix (1879).

Common about springs and wet places.

Laramie, August, 1891, B. C. Buffum; Whalen Canon, July 19, 1894 (No. 545); Lander Creek, August 31, 1894 (No. 1107).

Epilobium brevistylum, Barbey, Brewer & Wats. Bot. Cal. i, 220 (1876).

This specimen I had called *E. affine*, but a closer study of text and plate in Rev. Epilobium by Trelease leads me to believe that these specimens belong to the above.

Wind River Mountains, August 11, 1894 (No. 852).

Epilobium delicatum, Trelease, Mo. Bot. Garden Rep. ii, (1891).

Of the two specimens before me, the one seems nearly typical, the other is rather large flowered but too immature for close comparison.

Cummins, July 30, 1895 (No. 1466); Bald Mountain, August 15, 1892, B. C. Buffum.

Epilobium Hornemanni, Reichenb. Icon. Crit. ii, 73 (1824).

Again I have two specimens, one typical except that it is very dwarf; the other with leaves sessile instead of short petiolate. However, I am unable to refer them to any other species.

Bald Mountain, August 15, 1892; LaPlata Mines, August 23, 1895 (No. 1797).

Epilobium latifolium, L. Sp. Pl. i, 347 (1753). *Chamænerion latifolium* (L.) Sweet.

A rare and handsome species. The specimens before me may possibly be var. *grandiflorum*, Britton.

On a steep clay bank of the Gros Ventre River, August 16, 1894 (No. 1081).

Epilobium paniculatum, Nutt. T. & G. Fl. i, 490 (1840).

Common on sandy soil among small undershrubs on stream banks.

Wallace Creek, July 28, 1894 (No. 643); Cummins, July 28, 1895 (No. 1456).

Epilobium spicatum, Lam. Fl. Fr. iii, 482 (1778). *Chamænerion angustifolium*, (L.) Scop.

Common in the mountains, especially in districts recently burned over.

Garfield Peak, July 29, 1894 (No. 691). *Fire Weed.*

Epilobium suffruticosum, Nutt.

Large typical specimens were obtained on a dry, rocky creek bed.

Warm Spring Creek, August 10, 1894 (No. 798).

Clarkia Pulchella, Pursh, Fl. i, 260, t. 11 (1814).

Probably rare; specimens received from Snake River, May 29, 1892, collected by Fred McCullough.

Gayophytum racemosum, T. & G. Fl. i, 514 (1840).

This and the following species grow in the greatest profusion in the hills, in similar habitats, viz., dry banks, hillsides and ravines.

Sybille Creek, July 8, 1894 (No. 310); Table Mountain, July 1, 1895 (No. 1371); observed in many other localities.

Gayophytum ramosissimum, T. & G. Fl. i, 513 (1840).

Saratoga, June 23, 1893; Sybille Creek, July 8, 1894 (No. 308).

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Œnothera albicaulis, Nutt. Fraser's Cat. 1813. *Anogra pallida*, Britton.

Common on sandy ridges along the Laramie River.

Fisher's Ranch, June 19, 1894 (No. 264); Whalen Canon, July 17, 1894 (No. 511).

Œnothera biennis, L. Sp. Pl. 346 (1753). *Onagra biennis* (L.) Scop.

The specimens before me show considerable variation, but none of them seem to fall into any of the existing varieties.

Whalen Canon, July 18, 1894 (No. 519); Laramie Peak, August 8, 1895 (No. 1646).

Œnothera brachycarpa, Gray, Pl. Wright, i, 70.

On gravelly hillsides in the mountains; not frequent.

Centennial Valley, June 9, 1895 (No. 1274); Gros Ventre River, August 16, 1894 (No. 926).

Œnothera breviflora, T. & G. Fl. i, 506 (1840).

This was found in considerable abundance in one spot only, the naked soil of an old buffalo wallow.

Bacon Creek, August 25, 1894 (No. 1043).

Œnothera cæspitosa, Nutt. Gen. i, 246 (1818).

Abundant on the naked red clay hills near Laramie; May 23, 1894 (No. 58); May 30, 1895 (No. 1221).

Œnothera coronopifolia, T. & G. Fl. N. A. i, 495 (1840). *Anogra coronopifolia*, (T. & G.) Britton.

Common on the Laramie Plains.

University Campus, June 1894 (No. 222); June 1895 (No. 1426).

Œnothera Hartwegi, Benth. Pl. Hartw. v, (1843).

On dry, gravelly clay hills; not common.

Blue Grass Creek, July 9, 1894 (No. 375).

Œnothera Hartwegi lavandulæfolia, Watson, Proc. Am. Acad. viii, 590 (1873).

These specimens are from type locality, viz., "Plains of the Platte." Seemingly quite rare.

Whalen Canon, July 18, 1894 (No. 526).

Œnothera pinnatifida, Nutt. Gen. i, 245 (1818). *Anogra albicaulis*, (Pursh) Britton.

Frequent on sandy river bottoms.

Wheatland, July 9, 1894 (No. 380); North Fork Wind River, August 9, 1894 (No. 779).

Œnothera serrulata, Nutt. Gen. i. 246 (1818). *Meriolix serrulata,* (Nutt.) Walp.

Infrequent; Orin Junction, August 14, 1891, B. C. Buffum; Whalen Canon, July 18, 1894 (No. 524).

Œnothera trichocalyx, Nutt. T. & G. Fl. i, 494 (1840).

Particularly rare in the state; only a few specimens secured.

Bull Lake Creek, August 8, 1894 (No. 730).

Œnothera triloba, Nutt. Journ. Acad. Phil. ii, 118 (1821). *Lavauxia triloba,* (Nutt.) Spach.

Gaura coccinea, Nutt. Fraser's Cat. (1813).

A common weed everywhere.

Uva, July 10, 1894 (No. 367); Laramie, July 24, 1895 (No. 1430).

Gaura parviflora, Dougl. Hook. Fl. Bor. Am. i, 208 (1833).

Belonging to the lower altitudes of the state.

Two Bar Ranch, Blue Grass Creek, July 9, 1894 (No. 376).

LOASACEÆ.

Mentzelia albicaulis, Dougl. Hook. Fl. Bor. Am. i, 222 (1833).

In sandy thickets along streams or on hillsides.

Grant, on Sybille Creek, July 8, 1894 (No. 336); Cummins, July 28, 1895 (No. 1471).

Mentzelia chrysantha, Engelm.

This is probably rare, as only a few specimens were observed. No citations are at hand; reported from Canon City, Colo., and southern Utah in Coulter's Manual.

Big Wind River, August 5, 1894 (No. 705).

Mentzelia dispersa, Watson, Proc. Am. Acad, xi, 115 and 137.

Common in dry ravines in the hills.

Table Mountain, June 30, 1895 (No. 1375); Cummins, July 28, 1895 (No. 1455).

Mentzelia lævicaulis, T. & G. Fl. N. A. i, 535 (1840).

In disintegrated eruptive rock, Garfield Peak, July 29, 1894 (No. 678).

Mentzelia Nelsonii, Greene, Erythea, iii, 70 (1895).

The following is the original description: "Annual, 2 or 3 feet high, freely and widely branching, the stoutish branches with a sparingly hispidulous whitish bark; lower leaves unknown, those of the branches from distinctly hastate-ovate to almost deltoid-ovate,

1 or 2 inches long, coarsely toothed or indistinctly lobed, both faces green and rather sparsely appressed-hispidulous, the hairs of the upper surface stouter and more enlarged at base; flowers many, small, orange-colored, sessile, or nearly so, in the forks and axils; ovary subcylindric, less than one-half inch long at flowering time and after; calyx-lobes slenderly subulate at flowering, almost as long as the ovary; petals 5 only, about 4 lines long; stamens few; filaments filiform; anthers suborbicular; capsule and seeds unknown. A very well marked species, certainly allied to the Mexican *M. aspera*, but much larger and more diffusely branching, the leaves relatively broader."

It is probably quite local; collected in a canon leading to the Platte River, July 13, 1894 (No. 439).

Mentzelia nuda, T. & G. Fl. N. A. i, 535 (1840).

Frequent, and always in abundance; sandy plains and hillsides; somewhat variable as to habit.

Big Sandy, July 18, 1892; Grant, July 8, 1894 (No. 338); Cummins, July 29, 1895 (No. 1470).

Mentzelia ornata, T. & G. Fl. N. A. i, 534 (1840).

Also common on sandy foothills near the Platte and its tributaries.

Fairbanks, July 14, 1894 (No. 486); Big Horn Mountains, August 5, 1892.

Mentzelia pumila, T. & G. l. c.

On a stony, gravelly hillside, Cummins, July 29, 1895 (No. 1436).

CACTACEÆ.

It is not at all probable that the following numbers represent at all adequately our *Cactaceæ*, but the difficulty of preparing good specimens has caused them to be neglected.

Cactus viviparus, Nutt. in Fraser's Cat. (1813).

This is exceedingly rare; only two plants thus far observed.

Ione Ranch, on Laramie River, August 10, 1895 (No. 1865).

Echinocactus Simpsoni, Engelm. Trans. St. Louis Acad. ii, 197 (1863).

Frequent on the plains and in the valleys of the Laramie range.

Laramie, June 15, 1894 (No. 75).

Cereus viridiflorus, Engelm. Pl. Fendl. 50 (1849).

Rare, seemingly confined to the east slopes of the Laramie range. Pole Creek, June 2, 1894 (No. 113).

Opuntia fragilis (?) Haw. Suppl. Pl. Succ. 82 (1819).

A few specimens from Fairbanks, on the Platte, are thought to belong here. July 14, 1894 (No. 465).

Opuntia polyacantha platycarpa, (Engelm.) Coulter, Contrib. Natl. Herb. (III) vii, 436 (1896).

Probably several varieties of this species are found on our plains, but no specimens are at hand except of this. On the dry, gravelly plains the species, in some form, is immensely abundant, forming in places almost continuous beds.

Table Mountain, June 2, 1894 (No. 115).

UMBELLIFERÆ.

Sanicula Marylandica, L. Sp. Pl. 235 (1753).

Rare in the parts of the state collected, but probably frequent in the northeast.

Laramie Peak, August 8, 1895 (No. 1607).

Musenium tenuifolium, Nutt. T. & G. Fl. N. A. i, 642 (1840). *Adorium tenuifolium,* (Nutt.) Kuntze.

Usually reported as rare, but it is found in the greatest profusion in the Laramie range, on rocky ridges. June 7, 1894 (No. 176); Platte Hills, July 11, 1894 (No. 391).

Musenium trachyspermum, Nutt. l. c.

Common on the Laramie plains, appearing very early.

Laramie, May 7, 1894 (No. 10); observed outside of Laramie but not collected.

Bupleurum Americanum, C. & R.

Seemingly quite rare; a fine species.

Union Pass, August 14, 1894 (No. 893).

Bupleurum ranunculoides, L. Sp. Pl. 237 (1753).

Judging by place of collection, this may be denominated alpine.

Teton Peaks, August 21, 1894 (No. 972).

Harbouria trachypleura, C. & R.

Frequent in fertile mountain valleys at 7,000-8,000 ft.

Table Mountain, June 2, 1894 (No. 160); Saw Mill Creek, May 25, 1895 (No. 1238).

Cicuta maculata, L. Sp. Pl. 256 (1753).

In wet places along streams, particularly in the lower altitudes.

Lusk, July 21. 1894 (No. 573); Meadow Creek, August 9, 1894 (No. 790); Laramie River, near Ione Ranch, August 10, 1895 (No. 1557).

Carum Gairdneri, B. & H. Gen. Pl. i, 891.

In fertile valleys in the mountains, particularly such as are partially covered with undershrubs. The "Yamp" of the Indians.

Garfield Peak, July 29, 1894 (No. 660); Gros Ventre River, August 18, 1894 (No. 1096).

Zizia cordata, DC. Prodr. iv, 100 (1830).

Along streams and on moist hillsides even to their summits.

Horse Creek, June 9, 1894 (No. 204); Pole Creek, June 29, 1895 (No. 1327).

Sium cicutæfolium, Gmelin. Syst. ii, 482 (1791).

In the margins of fresh water lakes and ponds.

Bull Lake, August 8, 1894 (No. 731); Laramie River, August 10, 1895 (No. 1665).

Osmorrhiza nuda, Torr. Pac. Rep iv, 93 (1857).

In copses along most of our streams.

Garfield Peak, July 29, 1894 (No. 650); Centennial Valley, August 19, 1895 (No 1722).

Cymopterus montanus, T. & G. Fl. N. A. i, 624 (1840).

One of the earliest plants on the plains and hills.

Laramie, May 7, 1894 (No. 9); specimens from previous years also in the herbarium.

Ligusticum apiifolium, Benth. & Hook. Gen. Pl. i, 912.

A species with handsome foliage, quite rare.

Union Pass, August 11, 1894 (No. 832).

Ligusticum filicinum, Watson, Proc. Am. Acad. xi, 140.

These specimens were not secured until after most of the fruit had fallen off, but the remaining fruits and foliage made satisfactory determination possible.

Gros Ventre river, August 18, 1894 (No. 1095).

Ligusticum scopulorum, Gray, Proc. Am. Acad. vii, 347 (1868).

Fine specimens were collected at an unusual altitude, nearly 11,000 ft.

La Plata Mines, August 23, 1895 (No. 1784).

Ligusticum, sp.

The plants represented by numbers 1610 and 1655 are too immature to render determination certain, but Dr. Rose, to whom they were submitted, thinks it probable they are distinct species.

Oreoxis humilis, Raf.

Rare; Cummins, July 30, 1895 (No. 1431).

Selinum Grayi, C. & R.

In wet places at high elevations.

La Plata Mines, August 21, 1895 (No. 1776).

Angelica pinnata, Watson, King's Rep. v, 126 (1871).

Infrequent; along streams at 7,000-8,000 ft.

Upper Wind River, August 10, 1894 (No. 755).

Peucedanum graveolens, (?) Watson, King's Rep. v, 128 (1871). *P. Kingii*, Wats.

The material is scanty and over-ripe, but there is little doubt as to the correctness of the determination.

Garfield Peak, July 29, 1894 (No. 649).

Peucedanum nudicaule, Nutt. T. & G. Fl. N. A. i, 627 (1840).

Everywhere in the foothills, the naked scapes shooting up almost before the snow is off the ground.

Laramie, May 4, 1894 (No. 6); also on Horse Creek, June 6,1893.

Peucedanum simplex, Nutt. Wats. King Rep. v, 129 (1871).

Only a few specimens secured.

Union Pass, August 11, 1894 (No. 822).

Pastinaca sativa, L. Sp. Pl. 262 (1753).

Introduced at Cheyenne, where it was collected by B. C. Buffum, August 11, 1891. *Wild Parsnip.*

Heracleum lanatum, Michx. Fl. Bor. Am. i, 166 (1803).

On all streams, growing in the greatest profusion in the thickets at the water's edge.

Horse Creek, July 11, 1891; collected also high up on the Tetons, August 21, 1894 (No. 1055).

ARALIACEÆ.

Aralia hispida, Vent. Hort. Cels. t. 41.

The herbarium contains a single specimen collected by B. C. Buffum in 1892, no locality given. It most probably is from the north-eastern part of the state.

CORNACEÆ.

Cornus stolonifera, Michx. Fl. i, 92 (1803).

An exceedingly common shrub in thickets on most of our streams.

Wallace Creek, July 29, 1894 (No. 663); Little Sandy, August 31, 1894 (No. 1125); Table Mountain, July 1, 1895 (No. 1407).

CAPRIFOLIACEÆ.

Sambucus melanocarpa, Gray, Proc. Am. Acad. xix, 76 (1883).

Frequent in rocky canons throughout the state.

Telephone Canon, June 15, 1894, (No. 253); Union Peak, August 13, 1894 (No. 1026); Centennial Valley, August 18, 1895 (No. 1690).

Viburnum pauciflorum, Pylaie. T. & G. Fl. N. A. ii, 17 (1841).

Reported abundant near Sundance, specimens communicated by Mr. H. J. Chassel, September 1, 1895.

Symphoricarpos occidentalis, Hook. Fl. Bor. Am. i, 285 (1834).

On sandy creek banks as an undershrub in the thickets.

Blue Grass Creek, July 8, 1894 (No. 324); Laramie Peak, August 8, 1895 (No. 1565).

Symphoricarpos oreophilus, Gray; Journ. Linn. Soc. & Bot. Calif.

In the hills and mountains only at considerable elevations.

Casper Mountain, July 26, 1894 (No. 608); Cummins, July 29, 1895 (No. 1509).

Symphoricarpos racemosus pauciflorus, Robbins, Gray, Man. Ed. 5, 203 (1867). *S. pauciflorus,* (Robbins) Britton.

A few specimens secured on the eastern slope of the Tetons, August 21, 1894 (No. 958).

Lonicera involucrata, Banks, Richards. Bot. App. Ed. 2, 6 (1823).

Very common on little mountain streams; frequently called *Grouse Berries.*

Upper Wind River, August 10, 1894 (No. 758); Cummins, July 30, 1895 (No. 1482).

Lonicera Utahensis, Wats. Bot. King Surv. 133 (1871).

This I think to be very rare in the state.

Teton Mountains, August 21, 1884 (No. 934).

RUBIACEÆ.

Galium boreale, L. Sp. Pl. 108 (1753).

On every fertile mountain hillside and every valley in the greatest profusion.

Sybille Creek, July 8, 1894 (No. 343); Table Mountain, June 30, 1895 (No. 1384).

Galium trifidum, L. Sp. Pl. 105 (1753).

Common in wet places, as on the occasionally flooded banks of slow flowing streams.

Silver Creek, August 24, 1894 (No. 1115); Centennial Valley, August 19, 1895 (No. 1763).

Galium triflorum, Michx. Fl. i, 80 (1803).

Not common, collected on a wet, shaded hillside.

Centennial Valley, August 17, 1895 (No. 1693).

VALERIANACEÆ.

Valeriana edulis, Nutt.; Torr & Gray, Fl. ii, 48 (1841).

Very plentiful in the wet meadows bordering the Laramie River.

Fisher Ranch, June 19, 1894 (No. 262).

Valeriana Sitchensis, Bong. Veg. Sitch. 145.

Fine specimens were secured at Clark's, but not observed elsewhere.

Upper Wind River, August 10, 1894 (No. 793).

Valeriana sylvatica, Banks; Richards Bot. App. 730 (1823).

On wooded hillsides and in wet valleys in the Laramie Mountains. This species is very abundant.

Telephone Canon, June 15, 1894 (No. 228). Observed in a large number of other places.

COMPOSITÆ.

Brickellia grandiflora, Nutt. Trans. Am. Phil. Soc. vii, 287 (1841).

Coleosanthus grandiflorus, (Hook.) Kuntze.

Frequent on hillsides near the Platte and its tributaries.

Fairbanks, July 10, 1894 (No. 423); Cummins, July 30, 1895 (No. 1687).

Kuhnia eupatorioides, L. Sp. Pl. Ed. 2. 1662 (1763).

Infrequent; Laramie, September 1893.

Kuhnia eupatorioides corymbulosa, T. & G. Fl. N. A. ii, 78 (1841). *K. glutinosa,* Ell.

Probably confined to the eastern part of the state.

Cliffs, near Cold Spring, July 14, 1894 (No. 457).

Liatris punctata, Hook. Fl. Bor. Am. i: 306, t. 55 (1833). *Lacinaria punctata,* (Hook.) Kuntze.

Abundant in the northern part of Albany and Laramie counties.

Wheatland, June 30, 1892, B. C. Buffum; Laramie Peak, August 7, 1895 (No. 1564).

Liatris scariosa, Willd. Sp. Pl. iii, 1635 (1804). *Lacinaria scariosa,* (L.) Hill.

The range of this is about the same as the last but it prefers the rich loam of the valleys.

Inyan Kara Divide, August 30, 1892, B. C. Buffum; Laramie Peak, August 8, 1895 (No. 1651).

Liatris squarrosa intermedia, D C. Prodr. v, 129 (1836). *Lacinaria squarrosa intermedia,* (Lindl.) Porter.

Apparently quite local, in the northern part of Laramie county.

Rawhide Creek, September 4, 1892, B. C. Buffum; Mexican Mines, July 20, 1894 (No. 588).

Gutierrezia Euthamiæ, T. & G. Fl. N. A. ii, 193 (1841). *G. Sarothrae,* (Pursh) Britton & Rusby.

The most prevalent of our small undershrubs, particularly on the plains.

University Campus, September 12, 1894 (No. 1133); frequent also on the plains of the Platte.

Grindelia squarrosa,, Dunal in D C. Prodr. v, 315 (1836).

Abundant in all parts of the state thus far traversed.

Meadow Creek, August 9, 1894 (No. 777); Laramie, September 16, (No. 1148).

Chrysopsis villosa, Nutt. Gen. ii, 151 (1818).

In this polymorphous species, with so many intermediate forms, it becomes difficult to say which should receive varietal names. Some of the specimens before me, however, are typical.

Platte River, July 14, 1894 (No. 481); Hartville, July 18, 1894 (No. 585), a very villous form.

Chrysopsis villosa canescens, Gray, Syn. Fl. 123 (1886).

The commoner form in the north-western part of the state.

Gros Ventre River, August 16, 1894 (No. 1084); also observed in the Teton Mountains.

Chrysopsis villosa hispida, Gray, Proc. Acad. Phila. 1863, 65.

This is the form prevalent on the plains about Laramie,

State Fish Hatchery grounds, July 1891, B. C. Buffum.

Chrysopsis villosa viscida, Gray, Syn. Fl. 123 (1886).

A characteristic mountain form common in the Medicine Bow range.

Cummins, July 28, 1895 (No. 1497).

Aplopappus acaulis, Gray, Proc. Am. Acad. vii, 353.

Frequent and abundant on the Laramie Plains and in the foothills.

Laramie Hills, June 1893; plains, west of Laramie, June 9, 1895 (No. 1250).

Aplopappus acaulis glabratus, Eaton, Bot. King's Exp. 161.

Laramie, 1893. The month not noted, but it was probably collected late in the season.

Aplopappus armerioides, Gray, Syn. Fl. i, 132 (1886). *Stenotus armerioides*, Nutt.

Found only on the "red hills" near Laramie.

June 15, 1894 (No. 227).

Aplopappus Fremonti, Gray, near var. **Wardi,** Gray, Syn. Fl. i. 128.

This fine form I at first thought must be a *Bigelovia* as it was rayless, but Mr. M. L. Fernald, who kindly made comparison for me with the specimens in the Harvard herbarium, finds that my specimens correspond closely with Ward's the main difference being that mine have longer pappus.

Plains, ten miles north of Laramie, August 1, 1895 (No. 1553).

Aplopappus lanceolatus, T. & G. Fl. ii, 241.

Frequent on grassy slopes and in the valleys of the foothills.

Laramie, August 1894; Poison Spider Creek, July 27, 1894 (No. 624).

Aplopappus Lyalli, Gray, Proc. Acad. Phila. 1863, 64.

Quite typical specimens of this fine alpine plant were secured.

Union Pass, August 13, 1894 (No. 1012).

Aplopappus Nuttallii, T. & G. Fl. N. A. ii, 242 (1842). *Eriocarpum Grindelioides*, Nutt.

Collected on wet alkali flats.

Laramie, October 1893.

Aplopappus Parryi, Gray, Am. Journ Sci. Ser. 2, xxxiii, 10.

In partially shaded woods among the fallen trees.

Centennial Hills, August 17, 1895 (No. 1695).

Aplopappus pygmæus, Gray, Am. Journ. Sci. Ser. 2, xxxiii, 239.

Sparingly found on the bleak, rocky summits of the Medicine Bow Mountains, dwarf and somewhat cæspitose.

La Plata Mines, August 23, 1895 (No. 1875).

Aplopappus spinulosus, D C. Prodr. v, 347 (1836). *Eriocarpum spinulosum*, (Pursh) Greene.

Very abundant, in some localities becoming a weed.

Sheridan Experiment Farm, September 1895, J. F. Lewis; Cold Springs, July 14, 1894 (No. 456).

Aplopappus uniflorus, T. & G. Fl. ii, 241.

So far found only in the north-western part of the state.

Bacon Creek, August 15, 1894 (No. 911); Green River, August 26, 1894 (No. 1035).

***Bigelovia collinus,** (Greene). *Chrysothamnus collinus*, Greene.

For this specimen I am indebted to Prof. Greene. It is quite distinct from all the other forms I have secured.

Rock Springs, August 9, 1895, Prof. E. L. Greene.

Bigelovia Douglasii, Gray, Proc. Am. Acad. viii, 645 (1873).

The determination was made by Dr. Rose, but it should be added that the specimens are somewhat immature, and, as stated by him, not in condition to determine with certainty.

Laramie, 1893.

Bigelovia Douglasii lanceolata, Gray, Syn. Fl. 140 (1886).

I judge the specimens before me to be nearly typical; they come from within the type locality as well.

Union Pass, August 14, 1894 (No. 889); also from Bacon Creek.

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*The nomenclature of this genus is in such a state of confusion, that for the present I adopt that which allows of the quickest and easiest disposition of my material. My library facilities are too meager for me to presume to pass upon the relative merits of Dr. Gray's Bigelovia; Dr. Britton's Chondrophora, and Prof. Greene's Chrysothamnus.

Bigelovia Douglasii pumilla, Gray, Syn. Fl. 140 (1886).

Of frequent occurrence and apparently throughout the state.

In 1894 successively at Garfield Peak, Bacon Creek, Boulder Creek and at Laramie, (Nos. 616, 902, 1121, 1197).

Bigelovia Douglasii Stenophylla, Gray, Proc. Am. Acad. viii, 644 (1873).

Certainly very rare; noted but once.

Centennial Valley, August 26, 1895 (No. 1847).

Bigelovia Douglasii tortifolia, Gray, l. c.

These varieties run so closely together that it is difficult to speak with certainty regarding them.

Poison Spider Creek, July 26, 1894 (No. 617).

Bigelovia graveolens, Gray, l. c.

Good specimens of this were obtained on the Platte. Common in the canons and foothills near the river.

Platte River July 14, 1894 (No. 503).

Bigelovia graveolens albicaulis, Gray, l. c. *Chrysothamnus frigidus*, Greene, Erythea, iii, 112 (1895).

This is by far the most abundant form on the Laramie Plains, where in places it forms an almost uninterrupted growth for miles at a stretch.

Its characteristics are so well marked that Prof. Greene is well justified in raising it to specific rank.

Laramie, August 29, 1891, B. C. Buffum; E. L. Greene, August 1895; Bacon Creek, August 15, 1894 (No. 910).

Bigelovia graveolens glabrata, Gray, l. c.

This variety was observed only on the Pacific slope.

Bacon Creek, August 23, 1894 (No 966); Boulder Creek, August 26, (No. 1120).

Bigelovia Howardii, Gray, Proc. Am. Acad. viii, 641 (1873).

Prof. Greene * notes this form as peculiar to mountain parks of Colorado. This was secured in a similar location in Wyoming.

Centennial Valley, August 26, 1895 (No. 1846).

Bigelovia linifolia, (Greene). *Chrysothamnus linifolius*, Greene.

For this specimen also I am indebted to Prof. Greene; however, on comparing with our material, I find one listed as *B. Douglasii*

*Erythea, iii, 114.

lanceolata that perfectly accords with it. This I cut out and place here.

Rock Springs, August 9, 1895, E. L. Greene; Poison Spider Creek, July 26, 1894 (No. 618).

Solidago Canadensis, L. Sp. Pl. 878 (1753).

Probably confined to the lower altitudes of the eastern part of the state.

C. Y. Ranch, Big Muddy, July 23, 1894 (No. 597).

Solidago elongata, Nutt. Trans. Am. Phil. Soc. n. ser. vii, 328 (1841).

Frequent on the lower courses of mountain streams.

Big Muddy Creek, July 24, 1894 (No. 641); Cummins, July 27, (No. 1479). Also observed on Meadow Creek, 1894.

Solidago humilis nana, Gray, Proc. Am. Acad. viii, 389.

Infrequent, 9,000 ft. and upward.

Centennial Valley, August 18, 1895 (No. 1680).

Solidago Missouriensis, Nutt. Journ. Acad. Phila. vii, 32 (1834).

The species is much rarer with us than the following varieties.

Laramie Peak, August 8, 1895 (No. 1629).

Solidago Missouriensis extraria, Gray, Proc. Am. Acad. xvii, 195.

This seems to be the form on the western slope of the Rockies.

Bacon Creek, August 15, 1894 (No. 912).

Solidago Missouriensis montana, Gray, l. c.

Very common in dry, clayey ravines and on the adjoining hillsides near the Platte and its tributaries.

Uva, July 10, 1894 (No. 382); Cottonwood Canon, August 5, 1895 (No. 1571).

Solidago multiradiata, Ait. Hort. Kew. iii, 218 (1789).

Frequent in the mountains.

Warm Spring Creek, August 10, 1894 (No. 800); LaPlata Mines, August 22, 1895 (No. 1771).

Solidago multiradiata scopulorum, Gray, Proc. Am. Acad. xvii, 191 (1882).

Only a few specimens were secured, at high elevations, probably 10,000 ft.

Teton Mountains, August 22, 1894 (No. 955).

Solidago nana, Nutt. Trans. Am. Phil. Soc. vii, 327.

Not frequent. Upper Wind River, August 10, 1894 (No. 765).

Solidago rigida, L. Sp. Pl. 880 (1753).

Not observed by the writer, but good specimens from the northeastern part of the state.

Suggs Road, August 15, 1892, B. C. Buffum; Sheridan Experiment Farm, September 1895, J. F. Lewis.

Townsendia grandiflora, Nutt. Trans. Am. Phil. Soc. n. ser. vii, 306 (1841).

Frequent on the sandy plains in the eastern part of the state.

Uva, July 9, 1894 (No. 385); Pole Creek, June 30, 1895 (No. 1366).

Townsendia sericea, Hook. Fl. Bor. Am. 119 (1834). *T. exscapa,* (Richards) Porter.

So far as my observation goes, this is the very earliest flower of southeastern Wyoming. Abundant on the plains and in the foothills.

Collected May 5, 1894 (No. 7); observed on several years as early as the first week in April.

Aster adscendens, Lindl. Hook. Fl. Bor. Am. ii, 8 (1834).

I find this as variable as it is common in the state.

Nearly typical specimens from Bacon Creek, Silver Creek, Sweetwater River and Laramie, late August and September (Nos. 1052, 1110, 1196 and 1149).

A very peculiar form from Myersville, September 5, 1894 (No. 1193). This will probably prove to be a good variety at least. Other specimens from Laramie Peak are not typical, but for the present they are placed here. (Nos. 1561 and 1639).

Aster adscendens frondeus, Gray.

The citation for this name, which was communicated to me by Prof. Greene, I am unable to give. The specimens indicate a good variety at least.

Bacon Creek, August 25, 1894 (No. 1049).

Aster adscendens, Lindl. var. ?

Three quite different forms I have listed as possible varieties— No. 892 from Bacon Creek, Nos. 964 and 1092 from Gros Ventre River.

Aster canescens, Pursh. Fl. Am. Sept. 547 (1814). *Machæranthera canescens,* Gray.

The specimens seem hardly typical, but neither are they referable to any of the established varieties.

Bacon Creek, August 15, 1894 (No. 904); Gros Ventre River, August 17, 1894 (No. 1089).

Aster canescens latifolius, Gray, Torr. in Emory Rep. 141.

Infrequent; on eastern slope of partially wooded mountain side. Laramie Peak, August 7, 1895 (No. 1636).

Aster canescens viridis, Gray, Syn. Fl. 206 (1886).

A very abundant plant on the Laramie Plains, in places a troublesome weed.

University Campus September 15, 1894 (No. 1150).

Aster commutatus, Gray, Syn. Fl. 185 (1884). *A. incanopilosus,* (Lindl.) Sheldon.

Exceedingly abundant everywhere, some of its forms shading off into *A. multiflorus.*

Big Muddy Creek, July 23, 1894 (No. 598); Laramie, October 10, 1894 (No. 1170).

Aster conspicuus, Lindl. Hook. Fl. Bor. Am. ii, 7 (1840).

Infrequent; on a partially wooded slope in the Gros Ventre Mountains, near the Gros Ventre River, August 22, 1894 (No. 1069).

Aster elegans, T. & G. Fl. N. A. ii, 159.

This beautiful species seems to belong to the northeastern part of the state, in partially open hillsides.

Union Pass, August 11, 1894 (No. 826); Gros Ventre, August 22 (No. 1068).

Aster Engelmanni, Gray, Bot. King Surv. 144 (1871).

In a rather open copse on the banks of a canon stream.

Centennial Valley, August 17, 1895 (No. 1691).

Aster foliaceus, Lindl. DC. Prodr. v, 228 (1836).

The specimens are typical except that they are somewhat dwarf.

Wheatland, July 14, 1891, B. C. Buffum.

Aster foliaceus Burkei, Gray, Syn. Fl. 193 (1884).

Three good varieties of this at hand, this one from Little Sandy Creek, August 30, 1894 (No. 1132).

Aster foliaceus Eatoni, Gray, Syn. Fl. 194 (1884).

East Fork, August 25, 1894 (No. 1118).

Aster foliaceus frondeus, Gray, Syn. Fl. 193 (1884).

Centennial Valley, August 25, 1895 (No. 1859).

Aster Fremontii, Gray, T. & G. Fl. N. A. ii, 503.

No data on this specimen except collected near Laramie, October 3, 1891, by B. C. Buffum.

Aster frondosus, T. & G. Fl. N. A. ii, 165. *Brachyactis frondosa,* Gray.

Frequent in low, wet ground, especially in alkali soil, on the hummocks in alkali bogs.

Typical specimens from Laramie, September 7, 1895 (No. 1867); specimens from Seven Mile Lake, October 15, 1894 (No. 1159), remarkable for their size and the great number of large flowers.

Aster glaucus, T. & G. Fl. N. A. ii, 172.

In the foothills of all the mountain ranges yet collected.

Big Wind River, August 10, 1894 (No. 772); Laramie, September 30, 1894 (No. 1151); Laramie Peak, August 7, 1895 (No. 1590).

Aster lævis Geyeri, Gray, Syn. Fl. 183 (1884).

Collected by B. C. Buffum, Eagle Rock Canon, August 22, 1892.

Aster integrifolius, Nutt. Trans. Am. Phil. Soc. n. ser. vii, 291 (1841).

Belonging to the western or Pacific slope, observed only on the west side of Union Pass, August 13, 1894 (No. 1032).

Aster Lindleyanus, T. & G. Fl. N. A. ii, 122.

It was quite a surprise to find this species so far to the south and west.

Laramie Peak, August 6, 1895 (No. 1592).

Aster multiflorus, Ait. Hort. Kew. iii, 203 (1789).

Common throughout the state and quite variable as to habit, hirsuteness and size of flowers.

Big Muddy Creek, July 24, 1894 (No. 642); reported from Sheridan as a weed on the Experiment Farm.

Aster Parryi, Gray, Am. Nat. viii, 212.

This beautiful large flowered species is found in the greatest abundance in some parts of the Laramie Plains as is its congener *A. xylorrhiza.* Usually in separate districts but occasionally striving for the occupancy of the same hillside. Hybrids, I think, sometimes occur, for specimens are found with the characters of both species well blended. Preferring a red clay soil with a percentage of alkali in it.

Carbon, June 18, 1894 (No. 256), Miss Lily Boyd; Laramie Plains, June 20, 1895 (No. 1315).

Aster ptarmicoides, T. & G. Fl. N. A. ii, 160 (1841).

Rare; typical specimens from Bald Mountain, August 16, 1892, B. C. Buffum.

Aster pulchellus, Eaton, Bot. King Exp. 143.

This elegant alpine form occurs at least in the two principal ranges in the northern part of the state.

Bald Mountain, August 8, 1892, B. C. Buffum; Union Peak, August 13, 1894 (No. 1016)

Aster salicifolius, Ait. Hort. Kew. iii, 203.

From Jackson's Hole, near the base of the Teton Mountains, August 21, 1894 (No. 1065).

Aster tanacetifolius, H B K. Nov. Gen. & Sp. iv, 95 (1820).

Frequent on the sandy plains of the Platte. Uva, July 10, 1894 (No. 443). Observed in many other places.

Aster xylorrhiza, T. & G. Fl. N. A. ii, 158

This grows even more profusely than the above mentioned *A. Parryi*, but prefers soil with less alkali. Sandy clay ridges on the height of land between streams.

Laramie Plains, June 20, 1895 (No. 1315).

Erigeron acris, L. Sp. Pl. 863 (1753).

Infrequent and alpine; Laramie Peak, August 7, 1895 (No. 1621).

Erigeron armerifolius, D C. Prodr. v, 291 (1836).

Quite frequent along stream banks.

Head of Green River, August 14, 1894 (No. 908); Cummins, July 29, 1895 (No. 1480).

Erigeron cæspitosus, Nutt. Trans. Am. Phil. Soc. vii, 307 (1841).

Frequent on dry stony hillsides in the Laramie Mountains.

Blue Grass Creek, July 9, 1894 (No. 334); Cummins, July 30, 1895 (No. 1496).

Erigeron Canadensis, L. Sp, Pl. 863 (1753).

Sybille Creek, July 9, 1894 (No. 298); Whalen Canon, July 18, 1894 (No. 556).

Erigeron canus, Gray, Mem. Am. Acad. iv, 67 (1849).

My specimens of this are a little scanty and over ripe, but I think there is little doubt of the correctness of the determination.

Platte Canon, July 14, 1894 (No. 482).

Erigeron compositus, Pursh, Fl. ii, 535 (1814).

Observed only on a clayey, gravelly ridge at the head of Pole Creek, May 12, 1894 (No. 26); May 18, 1895 (No. 1217).

Erigeron compositus pinnatisectus, Gray, Proc. Am. Acad. xvi, 90 (1880).

In the Medicine Bow Mountains only as yet, 10,000 ft. and upward.

La Plata Mines, August 23, 1895 (No. 1816).

Erigeron trifidus, Hook. Fl. Bor. Am. ii, 17 (1834).

Near the summit of Laramie Peak, August 7, 1895 (No. 1612).

Erigeron corymbosus, Nutt. Trans. Am. Phil. Soc. vii. 308 (1841).

This fine mountain form is quite variable as to the number of heads. In three specimens from different localities I find the stems unicephalous, while only one has the typical corymbose arrangement.

Telephone Canon, June 15, 1894 (No. 234); Platte Hills, July 24, 1894 (No. 633); Union Pass, August 10, 1894 (No. 859); Centennial Hills, June 9, 1895 (No. 1290).

Erigeron Coulteri, Porter, in Fl. of Colo., 61.

Just a few fine specimens secured at Cummins, July 28, 1895 (No. 1524).

Erigeron divergens, T. & G. Fl. ii, 175 (1841).

Widely distributed, but not common.

Fine specimens from Snake River, Jackson's Hole, August 22, 1894 (No. 1053). Larger and more divergently branched plants from subalpine slopes on Laramie Peak, August 6, 1895 (No. 1635).

Erigeron flagellaris, Gray Mem. Am. Acad. iv, 68 (1849).

Immature and mature specimens present a very different appearance on account of the great lengthening of the stems without a corresponding increase in the number of leaves. Table Mountain, June 30, 1895 (No. 1386); Laramie Peak, August 6, 1895 (No. 1600).

Erigeron glabellus, Nutt. Gen. ii, 147 (1818). *E. asperus*, Nutt.

Our commonest Erigeron, everywhere abundant in wet meadows, somewhat variable.

Lander Creek, August 29, 1894 (No. 1117); Cummins, July 30, 1895 (Nos. 1454 and 1536). Specimens from several other localities.

Erigeron subtrinervis, Rydberg. *E. glabellus mollis,* Gray.

That this is worthy of the specific rank recently accorded it, I think no one will question.

Centennial Valley, August 17, 1895 (No. 1692).

Erigeron grandiflorus, Hook. Fl. ii, 123.

Bald Mountain, August 15, 1892, B. C. Buffum, specimens with rays almost white; La Plata Mines, August 24, 1895 (No. 1805), rays purple.

Erigeron leiomeris, Gray, Syn. Fl. 211 (1884).

Collected on the Grand Teton at about 10,000 ft, at the foot of rocky ledges, August 21, 1894 (No. 1054).

Erigeron macranthus, Nutt. Trans. Am. Phil. Soc. vii, 310 (1841).

In mountain parks and meadows at 8,000 ft. and upward.

Garfield Peak, July 29, 1894 (No. 647); Cummins, July 30, 1895 (No. 1535).

Erigeron pumilus, Nutt. Gen. ii, 147 (1818).

Frequent in sandy, grassy valleys in the Laramie Mountains.

Laramie Hills, June 7, 1894 (No. 169); Table Mountain, June 30, 1895 (No. 1339); observed in many other localities.

Erigeron radicatus, Hook. Fl. ii, 17.

On dry, stony ridges and subalpine table lands.

State Fish Hatchery grounds, Laramie, May 28, 1892, B. C. Buffum; Table Mountain, June 2, 1894 (No. 143).

Erigeron salsuginosus, Gray, Proc, Am. Acad. xvi, 93 (1880).

Wyoming must be the natural home of this splendid species, judging by the luxuriance of its growth. Superb specimens with heads two inches in diameter are of frequent occurrence along our mountain streams.

Union Pass, August 12, 1894 (No. 895); Centennial Hills, August 16, 1895 (No. 1775).

Erigeron strigosus, Muhl. Willd. Sp. Pl. iii, 1956 (1804). *E. ramosus,* (Walt.) B. S. P.

Infrequent, Union Pass, August 11, 1894 (No. 851).

Erigeron uniflorus, L. Sp. Pl. 864 (1753).

This, with us, alpine form varies greatly as to size and hirsuteness.

Specimens from Teton Mountains, August 22, 1894 (No. 969), are only 1-2 inches high, the involucre hirsute with sparse light

colored hairs. Those from the Medicine Bow Mountains, August 23, 1895 (No. 1772) are 4-6 inches high, stems bearing 4-6 leaves; involucre densely black lanate, rays white, heads 1 inch in diameter. I suggest the varietal name **melanocephalus** for this form.

Erigeron ursinus, Eaton, Bot. King's Exp. 148 (1871).

On rocky hills and ledges, 7,000-11,000 ft., successively throughout the season.

Table Mountain, June 2, 1894 (No. 144); La Plata Mines, August 23, 1895 (No. 1795).

Filago depressa, Gray, Proc. Am. Acad. xix, 3.

Not having seen an authentic *F. depressa,* I give the above determination with some reservation. In a gravelly hollow near the Little Laramie River, Centennial Valley, August 19, 1895 (No. 1751).

Antennaria alpina, Gærtn. Fr. & Sem. ii, 410 (1791).

Frequent, on dry hillsides.

Union Pass, August 11, 1894 (No. 853); Centennial Valley, June 9, 1895 (No. 1265).

Antennaria Carpathica pulcherrima, Hook. Fl. i, 329 (1834).

Probably throughout the state, in the rich soil of thickets.

Pole Creek, June 9, 1894 (No 110); Union Pass, August 12, 1894 (No. 819).

Antennaria dioica, Gærtn. l. c.

Of this variable species we have our full share of forms. Laramie, Inyan Kara Divide, Wind River and Green River are places from which specimens are at hand (Nos. 762 and 885).

Antennaria dioica congesta. D C. Prodr. vi, 269.

This is of frequent occurrence, sometimes with closely depressed stems, at other times, stems several inches in length. Separable from the species by the compactness of the heads.

Laramie, June 28, 1894 (No. 291). A form with strikingly roseate bracts probably belongs here.

Antennaria racemosa, Hook. Fl. Bor. Am. i, 330 (1834).

Rare, and but a few specimens secured.

Union Pass, August 11, 1894 (No. 812).

Anaphalis margaritacea, Benth. & Hook. Gen. Pl. ii, 303 (1873).

Antennaria margaritacea, (L.) Hook.

In deeply shaded copses at the foot of mountains.

Tetons, August 21, 1894 (No. 959); Laramie Peak, August 8, 1895 (No. 1604).

Anaphalis margaritacea subalpina, Gray, Syn. Fl. 233 (1884).

On a rocky creek bed, Centennial Valley, August 16, 1895 (No. 1669).

Gnaphalium palustre. Nutt. Trans. Am. Phil. Soc. n. ser. vii, 404 (1841).

Not common. Wheatland, August 8, 1891, B. C. Buffum; Atlantic City, September 3, 1894 (No. 1186).

Iva axillaris, Pursh, Fl. Am. Sept. 743 (1814).

A troublesome weed in some localities; frequent on the sandy plains of the Platte.

Fairbanks, July 14, 1894 (No. 476). *Poverty Weed.*

Iva xanthifolia, Nutt. Trans. Am. Phil. Soc. (II) vii, 347 (1841).

Infrequent; Willow Creek, July 20, 1894 (No. 569); Cheyenne, August 11, 1891, B. C. Buffum.

Ambrosia psilostachya, D C. Prodr. v, 526 (1836).

An exceedingly annoying weed, its root-stocks making it almost impossible to destroy it by cultivation.

Wheatland, August 11, 1891, B. C. Buffum; Fairbanks, July 11, 1894 (No. 425); Laramie, September 30, 1894.

Ambrosia trifida, L. Sp. Pl. 987 (1753).

Infrequent in the state as yet.

Ford J. Ranch, on Willow Creek, July 21, 1894 (No. 563).

Franseria discolor, Nutt. Trans. Am. Phil. Soc. (II) vii, 345 (1841). *Gærtneria discolor,* (Nutt.) Kuntze.

One more of our weeds; "the more it is dug up the better it thrives."

University campus, July, 1891, B. C. Buffum; Hartville, July 15, 1894 (No. 550).

Franseria Hookeriana, Nutt. l. c. *Gærtneria acanthicarpa,* (Hook.) Britton.

Frequent on sandy plains.

Inyan Kara Divide, August 30, 1892, B. C. Buffum; Big Wind River, August 5, 1894 (No. 707); Sweetwater River, September 9, 1894 (No. 1196).

Xanthium Canadense, Mill. Gard. Dict. Ed. 8, No. 2 (1768).

Not frequent; Cheyenne, August 9, 1891, B. C. Buffum; Platte River, July 14, 1894 (No. 485).

Gymnolomia multiflora, Benth. & Hook. Rothr. Bot. Wheeler Surv. 160 (1876).

Only from Snake River thus far, August 21, 1894 (No. 1064).

Rudbeckia hirta, L. Sp. Pl. 907 (1753).

Common throughout the state.

Specimens from Cheyenne, Laramie, Big Muddy Creek, and Cummins, (Nos. 600, 1144, 1459).

Rudbeckia laciniata, L. Sp. Pl. 906 (1753).

Common on streams in eastern part of the state.

Cottonwood Canon, August 5, 1895 (No. 1575).

Lepachys columnaris, T. & G. Fl. N. A. ii, 314 (1842).

This and the following variety are common on the plains and hills about the Platte

Uva, July 10, 1894 (No. 386).

Lepachys columnaris pulcherrima, T. & G. l. c.

This form maintains itself pretty uniformly in given areas, so seems entitled to varietal name.

Willow Creek, July 20, 1894 (No. 570).

Balsamorrhiza sagittata, Nutt. Trans. Am. Phil. Soc. vii, 349 (1841),

Occasionally growing in the greatest profusion in dry, stony ravines.

Laramie Hills, by B. C. Buffum, June 24, 1892; June 9, 1894 (No. 213).

Balsamorrhiza macrophylla, Nutt. Trans. Am. Phil. Soc. vii, 350 (1841).

Very rare, but one specimen found.

Union Pass, August 10, 1894 (No. 921).

Wyethia amplexicaulis, Nutt. Trans. Am. Phil. Soc. vii, 349 (1841).

Infrequent; Laramie Hills, June 21, 1891, B. C. Buffum; Union Pass Hills, August 11, 1894 (No. 816).

Helianthus annuus, L. Sp. Pl. ii, 904 (1753).

A common weed in some localities.

Cheyenne, August 11, 1891, B. C. Buffum; Fairbanks, July 12, 1894 (No. 432).

Helianthus giganteus, L. Sp. Pl. 905 (1753).

Near streams and in wet bottoms; not frequent.

Muskrat Creek, July 30, 1894 (No. 684); Laramie, October 6, 1894 (No. 1169).

Helianthus Nuttallii, T. & G. Fl. N. A. ii, 324 (1842).

Secured only west of the Wind River Mountains.

Gros Ventre River, August 16, 1894 (No. 1083).

Helianthus pumilus, Nutt. Trans. Am. Phil. Soc. vii, 366.

Frequent on dry slopes and hilltops.

Platte River Hills, July 14, 1894 (No. 501); also from Casper.

Helianthus rigidus, Desf. Cat. Hort. Paris. Ed. 3, 184 (1813).

Whalen Canon, July 18, 1894 (No. 528); Laramie Peak, August 6, 1895 (No. 1578).

Helianthella quinquenervis, Gray, Proc. Am. Acad. xix, 10.

In the mountains, in open places near streams.

Bald Mountain, by B. C. Buffum; Union Pass, August 10, 1894 (No. 803); Laramie Peak, August 6, 1895 (No. 1654).

Thelesperma gracile, Gray, Kew. Journ. Bot. i, 252 (1849).

Frequent on the hills near the Platte Riiver.

Near Fort Laramie by B. C. Buffum; Blue Grass Hills, July 8, 1894 (No. 321).

Bidens frondosa, L. Sp. Pl. 832 (1753).

Frequent in the eastern part of the state.

Wheatland, September 1892; Sheridan Experiment Farm, September 1895, J. F. Lewis.

Bidens cernua, L. Sp. Pl. 832 (1753).

In wet places about Wheatland, September 1892, B. C. Bufium.

Madia glomerata, Hook. Fl. ii, 24.

A rare plant; in dry rich loam soil.

Big Wind River, August 2, 1892, B. C. Buffum; Laramie Peak, August 8, 1895 (No. 1593).

Chænactis Douglasii, Hook. & Arn. Bot. Beechy. 354 (1840-41).

On abrupt stony clay hills.

Mouth of Bacon Creek, August 15, 1894 (No. 909); Cummins, July 25, 1895 (No. 1439).

Chænactis Douglasii alpina, Gray, Syn. Fl. 341 (1884).

On subalpine stony hilltops; easily distinguished from the species by its striking rosette of radical leaves and its smaller size.

Garfield Peak, July 29, 1894 (No. 653); Cummins, July 26, 1895 (No. 1438).

Hymenopappus filifolius, Hook. Fl. Bor. Am. i, 317 (1833).

Frequent on the dry slopes of the Platte and Laramie River hills at 5,000-7,000 ft.

Sybille Creek, July 7, 1894 (No. 328); Table Mountain, June 29, 1895 (No. 1369).

Hymenopappus ligulæflorus, n. sp.

Perennial from a multicipital caudex, each division bearing one leafy stem, 5-8 inches high, glabrous but for some floccose wool on the crown of caudex; leaves simply pinnate into about five linear divisions, impressed punctate; heads few, corymbosely cymose, about ⅓ inch high; involucral bracts oblong, hirsute-villous on the margins, resinous-atomiferous as are also the corollas, the whole strong scented; rays 6-8, ⅓ inch long; lobes of disk corollas very short and erect; achenes short villous; pappus of thin acuminate paleæ, in this respect allying it more closely to *Hymenothrix*; flowers yellow.

Mr. L. Fernald, assistant in Gray Herbarium, who kindly examined it for me, reports it as a form of *H. filifolius*, but I cannot see why it should be left there.

Collected on the north Laramie Plains, about six miles from Owen, August 5, 1895 (No. 1573).

Bahia chrysanthemoides, Gray, Proc. Am. Acad. xix, 28.

Noted at Laramie Peak only, August 6, 1895 (No. 1634).

Bahia oppositifolia, Nutt. T. & G. Fl. N. A. ii, 376 (1842).

Common on the dry, sandy plains of the Platte; July 1894 (Nos. 332 and 602).

Eriophyllum cæspitosum, (Dougl.) Lindl. Bot. Reg. xiv, 1167 (1828).

Probably confined to the northwestern part of the state.

B. C. Buffum, in 1892 without data; Gros Ventre River, August 18, 1894 (No. 1099).

Eriophyllum cæspitosum leucophyllum, Gray, Proc. Am. Acad. xix, 25.

Very rare, in dry stony ravine.

Warm Spring Creek, Union Pass, August 10, 1894 (No. 801).

Dysodia chrysanthemoides, Lag. Nov. Gen. et Sp. 29 (1816). *D. papposa,* (Vent.) A. S. Hitchc.

Common in the eastern part of the state.

From Wheatland, by B. C. Buffum, August 11, 1891; Platte River, July 14, 1894 (No. 499).

Helenium autumnale, L. Sp. Pl. 886 (1753).

Very frequent on river bottoms.

Popo Agie River, August 1, 1894 (No. 736); Ione Ranch, August 10, 1895 (No. 1664).

Helenium Hoopesii, Gray, Proc. Acad. Phil. 65 (1863).

Infrequent; Union Pass, August 11, 1894 (No. 841).

Gaillardia aristata. Pursh, Fl. ii, 573.

Frequent and quite variable especially as to foliage. Probably throughout the state.

Platte River Hills, July 11, 1894 (No. 417); Pole Creek, June 27, 1895 (No. 1326).

Actinella acaulis, Nutt. Gen. ii, 173.

Very frequent indeed in various forms. the earlier individuals scapeless as well as stemless.

Laramie Hills, June 7, 1894 (No. 177); Table Mountain, June 27, 1895 (No. 1300).

Actinella glabra, (Nutt.) n. sp.

If ever a plant deserved specific rank, this one does. Many as are the forms of *A. acaulis,* by necessity, there is no excuse for making this one of them. It is clearly separated from that by the much longer branches of the caudex, which are closely covered with the persistent bases of dead petioles, all of which are completely enveloped in long, densely matted wool, brownish-red, except at the summit, where it becomes continuous with the white persistent wool of the scape and involucre. Leaves longer, glabrous and strongly impressed-punctate; heads large, 1 inch or even more across. Roots enormous, sometimes several feet in length; the multicipital caudex forming raised rounded tufts 6-12 inches across, which very early in the spring become covered with fine yellow heads. *A. acaulis glabra,* Gray. *A. glabra,* Nutt.

Exceedingly abundant in the Laramie Hills, where it is in blossom from April to June (Nos. 36 and 1233).

Actinella grandiflora, T. &. G. Bost. Journ. Nat. Hist. Soc. v, 110.
Rare; probably strictly alpine.
On the naked summits of the Medicine Bow Mountains, August 23, 1895 (No. 1822).

Actinella Richardsonii, Nutt. Trans. Am. Phil. Soc. vii, 379.
Rare; only a few specimens secured.
Centennial Hills, August 19, 1895 (No. 1688).

Actinella scaposa linearis, Nutt. Trans. Am. Phil. Soc. vii, 378.
This is a common species in sandy, grassy valleys in the hills.
Table Mountain, June 2. 1894 (No. 91); June 29, 1895 (No. 1341).

Achillea millefolium, L. Sp. Pl. ii, 899 (1753).
From the summits of our mountains to our lowest valleys.
Sybille Creek, July 8, 1894 (No. 409); Wind River Mountains, August 8, 1894.

Anthemis cotula, L. Sp. Pl. 894 (1753).
Introduced in Laramie and possibly elsewhere but apparently not thriving. It would soon disappear were in not reintroduced.
Laramie, October 1894 (No. 1160).

Tanacetum capitatum, T. & G. Fl. N. A. ii, 415.
Infrequent; Laramie, in the "red hills," June 15, 1894 (No. 226).

Artemisia biennis, Willd. Phytogr. 11 (1794).
Very common in waste ground about the city.
Laramie, September 18, 1894 (No. 1145).

Artemisia cana, Pursh. Fl. ii, 521.
This seems to belong to the western slope, where, in the fertile creek valleys, it is the prevailing species.
Bacon Creek, August 25, 1894 (No. 1042); Lewiston, September 5, 1894 (No. 1183).

Artemisia Canadensis, Michx. Fl. Bor. Am. ii, 129 (1803).
Of frequent occurrence on the Big Wind River; by B. C. Buffum, August 2, 1892; August 5, 1894 (No. 710); Laramie Peak, August 6, 1895 (No. 1660).

Artemisia dracunculoides, Pursh, Fl. Am. Sept. 742 (1814).
Infrequent in the parts of the state collected; Eagle Rock Canon, August 22, 1892, B. C. Buffum.

Artemisia filifolia, Torr. Ann. Lyc. N. Y. ii, 211 (1827).

This fine species is also rare unless it be in the northeastern part of the state.

Inyan Kara Divide, August 30, 1892, B. C. Bcffum.

Artemisia frigida, Willd. Sp. Pl. iii, 1838 (1804).

Perhaps the commonest of our long list of "sages," appearing everywhere on the dry plains and in the hills.

Union Pass, August 10, 1894 (No. 861); University campus, September 16, 1894 (No. 1135); Sheridan Experiment Farm, September 1895.

Artemisia Ludoviciana, Nutt. Gen. ii, 143 (1818).

Quite variable, differing especially as to foliage and compactness of panicle. On creek banks throughout the state.

Laramie, October 6, 1894 (No. 1171); Laramie Peak, August 5, 1895 (No. 1643).

Artemisia Ludoviciana integrifolia, n. var.

Leaves all entire, large, (1-3 inches long), narrowly lanceolate, margins revolute; panicle strict, heads fewer and larger than in the species.

Willow Creek, July 20, 1894 (No. 568).

Artemisia Mexicana, Willd. Spreng. Syst. iii, 490.

Infrequent; Sweetwater Stage Station, September 9, 1894 (No. 1181).

Artemisia Norvegica, Fries, in Liljeb. Fl. (1815).

A handsome plant, infrequent, alpine.

Union Peak, August 12, 1894 (No. 897).

Artemisia scopulorum, Gray, Proc. Acad. Phila. 66 (1863).

Probably in all our alpine regions.

Union Peak, August 13, 1894 (No. 989); La Plata Mines, August 22, 1895 (No. 1779).

Artemisia tridentata, Nutt. Trans. Am. Phil. Soc. (II) vii, 398 (1841).

This is the shrub that is generally designated by the term "sage brush," whereas the term sage is applied indiscriminately to the preceding. It is, perhaps, the most characteristic shrub of the Wyoming plains and valleys. Its presence indicates soil of good quality, reasonably free from alkali. Of very slow growth, but on

some creeks reaching the dignity of small trees and furnishing excellent fuel.

Boulder Creek, August 25, 1894 (No. 1111).

Artemisia trifida, Nutt. l. c.

No specimens of this species are at hand but it is known to be in the state.

Noted by Prof. W. C. Knight, on Seminoe Mountains, May 6, 1896, at about 8,000 ft. altitude.

Petasites sagittata, Gray, in Brew. & Wats. Bot. Cal. i, 407 (1876).

Tussilago sagittata, Pursh.

Rare; in a wet, boggy meadow.

Pole Creek, May 25, 1894 (No. 81).

Arnica alpina, Olin. Mon. Arn. Upsala (1799).

Very abundant about Table Mountain, where it was collected June 2, 1894 (No. 148); June 30, 1895 (No. 1383).

Arnica amplexicaulis, Nutt. Trans. Am. Phil. Soc. vii, 408.

Frequent in copses in fertile subalpine valleys.

Teton Mountains, August 21, 1894 (No. 933); Centennial Hills, August 19, 1895 (No. 1702).

Arnica Chamissonis, Less. Linnæa, vi, 317 (1831).

Frequent in the mountains.

Pine Creek, by B, C. Bufum; Union Peak, August 13, 1894 (No. 995); La Plata Mines, August 23. 1895 (No. 1785).

Arnica cordifolia, Hook. Fl. Bor. Am. i, 331 (1833).

Exceedingly abundant; in woods and copses in the mountains from their bases to their summits. Somewhat variable, the radical leaves often reduced and ovate rather than cordate.

Horse Creek June 9, 1894 (No. 215); Union Pass, August 10, 1894 (No. 871); also from the Centennial Valley.

Arnica foliosa, Nutt. Trans. Am. Phil. Soc. vii, 407.

Probably rare; collected only on upper Wind River, August 10, 1894 (No. 766).

Arnica foliosa incana, Gray, Bot. Cal. i, 416 (1876).

Specimens from Pine Creek, by Prof. B. C. Buffum, presumably nearly typical; others less so from Saratoga, July 2, 1893, by J. D. Parker.

Arnica latifolia, Bong. Veg. Sitch. 147.

A beautiful subalpine species, probably in all of our mountains.

Bald Mountain, B. C. Buffum, in August 1892; Union Pass, August 11, 1894 (No. 836); noted in Medicine Bow Mountains.

Arnica longifolia, Eaton, Bot. King Exp. 186.

Decidedly rare; Teton Mountains, August 21, 1894 (No. 957).

Senecio amplectens taraxacoides, Gray, Proc. Acad. Phila. 67 (1863).

Very rare; only a few specimens from the Teton Mountains, August 22, 1894 (No. 987).

Senecio aureus, L. Sp. Pl. ii, 870 (1753).

This and many of its varieties are well represented in our flora. The individual variation is often so great that it is difficult to assign some specimens to any of the numerous varieties already created.

Specimens from Green River, August 26, 1894 (No. 1036), and Wind River, August 10, 1894 (No. 760) I think are nearly typical, as are also some from Beaver Creek and Laramie, by B. C. Buffum.

Senecio aureus borealis, T. & G. Fl. N. A. ii, 442.

On the rocky slopes of the Teton Mountains, August 21, 1894 (No. 979).

Senecio aureus croceus, Gray, Proc. Acad. Phila. 68 (1863)

This is a frequent form in subalpine meadows.

Union Pass, August 10, 1894 (No. 858); La Plata Mines, August 20, 1895 (No. 1753).

Senecio aureus obovatus, T. & G. Fl N. A. ii, 442.

Typical specimens from Big Wind River, August 5, 1894 (No. 704); doubtful ones from La Plata Mines, August 23, 1895 (No. 1769).

Senecio Balsamitæ (?) Muhl. Willd. Sp. Pl. iii, 1998 (1804).

I think there is little doubt of the two sets of specimens before me belonging here; they lack the root leaves upon which the description partly hinges, but seem normal otherwise.

Eagle Rock Canon, August 2, 1892, B. C. Buffum; Cummins, July 30, 1895 (No. 1492).

Senecio canus, Hook. Fl. Bor. Am. i, 333 (1834).

This strongly marked species is of frequent occurrence in the state. Our specimens are large, stoloniferous and slightly decumbent at base.

Union Pass, August 10, 1894 (No. 761); Table Mountain, June 30, 1895 (No. 1364).

Senecio crassulus, Gray, Proc. Am. Acad. xix, 54.

Probably in the subalpine regions of all our mountains.

A large form in Union Pass, August 10, 1894 (No. 809); smaller and more typical, Union Peak, August 13, (No. 1027); La Plata Mines, August 21, 1895 (No. 1770).

Senecio Douglasii, D C. Prodr. vi, 429 (1837).

This is of frequent occurrence, the three main forms being represented: 1. Glabrous, stems branched, leaves broad, with broad, unequal lobes; rays long, narrow (6-10). This is probably the suppressed *Senecio fastigiatus,* Gray. 2. Slightly pubescent-tomentose stems paniculately branched only at summit; leaves pinnately parted into linear lobes, the rays few and inconspicuous. This form is Bentham's *Senecio longilobus.* 3. Glabrous, stems very numerous from a woody base, strict; leaves entire, linear; inflorescence a short cymose panicle; rays long and conspicuous. This is *Senecio Ridellii,* T. & G.

I see no reason why forms so distinct should not be kept separate. 1. From Pole Creek, July 1, 1895 (No. 1389); 2. Sybille Hills, July 8, 1894 (No. 302), and Cummins, July 27, 1895 (No. 1441); 3. Cummins, July 27, 1895 (No. 1440).

Senecio eremophilus, Richards. App. Frankl. Journ. Ed. 2, 31.

Infrequent; Cummins, July 29, 1895 (No. 1491).

Senecio Fendleri, Gray, Pl. Fendl. 108.

A very common form in stony clay hills.

Pole Creek, June 2, 1894 (No. 124); Centennial Valley, June 9, 1895 (No. 1297).

Senecio hydrophilus, Nutt.

Frequent, but never plentiful; in wet and sometimes boggy places.

Bacon Creek, August 15, 1894 (No. 915); Cummins July 28, 1895 (No. 1458).

Senecio integerrimus, Nutt. Gen. ii, 165.

Very frequent in fertile, open valleys in the mountains.

Union Pass, August 14, 1894 (No. 891); Teton Mountains, August 21, 1894 (No. 1002); Table Mountain, June 26, 1895 (No. 1333).

Senecio lugens, Richards. Bot. App. 748 (1823).

Very common and of many forms which probably are worthy of varietal distinction. The following numbers appear early on hillsides and valleys and are probably near the type:

Table Mountain, June 2, 1894 (No. 128); Centennial Valley, June 9, 1895 (No. 1305).

Senecio lugens foliosus, Gray, Bot. Cal. i, 413.

On hillsides, in rich loam soil among undershrubs.

Union Pass, August 13, 1894 (No. 999); Centennial Valley, June 9. 1895 (No. 1246).

Senecio lugens megalocephalus, n. var.

Radical leaves large, irregularly and coarsely dentate; cauline leaves small or wanting; stem branched from near the base into several slender branches 8-12 inches long, each bearing a few (3-5) large heads (5-8 lines high). The whole plant is very tardily glabrate. In thickets on moist hillsides.

Centennial Valley, June 9, 1895 (No. 1252).

Senecio rapifolius, Nutt.

Said to be a very rare plant.

Sweetwater River, September, 1894 (No. 1180); Laramie Peak, August 7, 1895 (No. 1589).

Senecio serra, Hook. Fl. Bor. Am. i, 333 (1834).

Infrequent; near Warm Spring Creek, August 10, 1894 (No. 771).

Senecio serra integriusculus, Gray, Syn. Fl. 387 (1884). *S. Andinus,* Nutt.

A rare plant; in the Union Pass hills, August 10, 1894 (No. 876).

Senecio triangularis, Hook. Fl. Bor. Am. i, 332 (1834).

On wet banks in copses in mountain canons.

Teton Mountains, August 21, 1894 (No. 936); Cummins, July 31, 1895 (No. 1519).

Senecio werneræfolius, Gray, Proc. Am. Acad. xix, 54.

Frequent in the "red hills" (Tertiary) about Laramie, June 15, 1894 (No. 224); Table Mountain, June 29, 1895 (No. 1379).

Tetradymia canescens, D C. Prodr. vi, 440 (1837).

On the dry plains of the Platte; Big Muddy Creek, July 23, 1894 (No. 605).

Tetradymia canescens inermis, Gray.

While not separated from the species by any strong botanical characters, yet readily distinguished by foliage and general habit.

Wallace Creek, July 29, 1894 (No. 656).

Cnicus altissimus filipendulus, Gray, Proc. Am. Acad. xix, 56.

Specimens received from Sheridan Experiment Farm seem to belong to this variety, probably introduced with farm seeds. September, 1895.

Cnicus Americanus, Gray, Proc. Am. Acad. xix, 56.

In the dry foothills near the Laramie River; not frequent.

Cummins, July 29, 1895 (No. 1512).

Cnicus arvensis, Hoffm. Deutch. Fl Ed. 2, I: Part 2, 130 (1804). *Carduus arvensis*, (L.)Robs.

Thus far this, the *Canada Thistle*, has been reported from only one place in the state.

Specimens from Sheridan, September 1895, J. F. Lewis.

Cnicus Drummondii, Gray, Proc. Am. Acad. x, 40. *Carduus pumilus*, Hook.

Very frequent throughout the state.

Laramie, September, 1893: Union Pass, August 14, 1894 (No. 881); Cummins, July 27, 1895 (No. 1469).

Cnicus lanceolatus, Hoffm. *Carduus lanceolatus*, L.

Becoming plentiful in vacant lots and along the irrigation ditches.

Cnicus ochrocentrus, Gray, Proc. Am. Acad. xix, 57 (1883).

In dry, open ground in the hills; frequent.

Laramie Hills, July 7, 1894 (No. 414); Gros Ventre River, August 22, 1894 (No. 1070).

Cnicus undulatus, Gray, Proc. Am. Acad. x, 42 (1874). *Carduus undulatus*, Nutt.

Frequent; Cheyenne, August 11, 1891, B. C. Buffum; Laramie, October 2, 1894 (No. 1156).

Cnicus Virginianus, Pursh, Fl. ii, 506 (1814). *Carduus Virginianus*, L.

Very rare; a few specimens from a dry bank, Cummins, July 30, 1895 (No. 1563).

Crepis acuminata, Nutt. Trans, Am. Phil. Soc. vii, 437.

On dry, sometimes stony ground, in the hills and mountains.

Laramie, July 7, 1894 (No. 356); Union Pass, August 10, 1894 (No. 919).

Crepis elegans, Hook, Fl. i, 297.

A very rare plant; noted but once.

Union Pass, August 12, 1894 (No. 1076).

Crepis glauca, T. & G. Fl. N. A. ii, 488 (1843).

Frequent in wet alkali meadow lands.

Meadow Creek, August 9, 1894 (No. 787); Centennial Valley, August 16, 1895 (No. 1673).

Crepis intermedia, Gray, Syn. Fl. 432 (1884).

Rare; secured by B. C. Buffum on the Wind River, August 2, 1892.

Crepis intermedia gracilis, Gray, Syn. Fl. 432 (1884).

Frequent on dry hillsides in the Laramie range.

Table Mountain, June 30, 1895 (No. 1393).

Crepis runcinata, T. & G. Fl. N. A. ii, 487 (1843).

Infrequent; secured by B. C. Buffum near Big Wind River, August 1, 1892.

Hieracium albiflorum, Hook. Fl. i, 298.

Abundant on a dry hillside among the fallen timber in a burned-over district.

Centennial Hills, August 16, 1895 (No. 1678).

Hieracium Canadense, Michx. Fl. ii, 86 (1803).

Infrequent; Wolf Creek, August 18, 1892, B. C. Buffum.

Hieracium Fendleri, Schultz, Bip. Bonplandia, ix, 173.

As near as I can judge without other material for comparison, these specimens are nearly typical.

Plentiful on the banks of the Little Laramie River, in the Centennial Valley, August 25, 1895 (No. 1857).

Hieracium gracile, Hook. Fl. i, 298.

Very typical specimens from the Medicine Bow Mountains, where in the alpine region it is found in the greatest profusion. August 23, 1895 (No. 1802).

A very diminutive form was secured on the Teton Mountains; radical leaves only 3-6, stems single, bearing one to four heads. Var. **minimum** would be a suitable designation. August 21, 1894 (No. 1060).

Hieracium Scouleri, Hook. Fl. i, 298.

Very abundant on the Gros Ventre Hills, but not observed east of the Wind River Mountains. August 23, 1894 (No. 963).

Troximon aurantiacum, Hook. Fl. i, 300, t. 104.

Infrequent; Pole Creek, June 29, 1895 (No. 1342).

Troximon aurantiacum purpureum, Gray, Proc. Am. Acad. xix, 72.

Found occasionally in the vicinity of Laramie; Pole Creek, June 30, 1895 (No. 1376); Hutton's Grove, August 9, 1891, B. C. Buffum.

Troximon cuspidatum, Pursh, Fl. Am. Sept. 742 (1814). *Nothocalais cuspidata* (Pursh) Greene.

Somewhat variable; only a few of my numerous specimens typical; possibly some of them should be cut out. Frequent but scattering.

Laramie, August 1893; Wallace Creek, July 29, 1894 (No. 673); from several other places and noted in many localities.

Troximon glaucum, Pursh, Fl. 505 (1814). *Agoseris glauca* (Pursh) Greene.

Frequent in the grassy valleys in the hills and mountains.

Eagle Rock Canon, August 22, 1892, B. C. Buffum; Union Pass, August 10, 1894 (No. 870).

Troximon glaucum dasycephalum, T. & G. Syn. Fl. 432 (1884).

Seemingly nearly alpine and occasionally very abundant.

Union Pass, August 10, 1894 (No. 868); La Plata Mines, August 21, 1895 (No. 1765).

Troximon glaucum laciniatum, Gray, Bot. Cal.

This form I have never been able to locate to my satisfaction, but I am unable to place it under any other name. It is of very frequent occurrence among the sage brush in the Laramie Hills; June 2, 1894 (No. 125); Pole Creek, June 29, 1895 (No. 1376).

Taraxacum officinale, Weber, Prim. Fl. Holst. 56 (1780). *T. Taraxacum,* (L.) Karst.

Apparently the *Dandelion* found its ideal home when it reached Laramie. It occupies every foot of ground along the irrigation ditches of our streets and takes complete possession of the lawns where eternal warfare is not waged upon it. In luxuriant growth and blossom from April to November (No. 80).

Taraxacum officinale alpinum, Koch. Fl. Germ. & Helv. 428 (1837).

Of the several forms of native Dandelions this seems to be the most frequent. Abundant in the high, grassy valleys of the Laramie range.

Pole Creek, June 2, 1894 (No. 109); Centennial Valley, August 17, 1895 (No. 1715).

Taraxacum officinale lividum, (?) Koch.

Some specimens collected by B. C. Buffum, 1892, are doubtfully placed here, and some with nearly entire glaucesent leaves are for the present passed over.

Lactuca leucophæa, Gray, Proc. Am. Acad. xix, 73.

Probably very rare in the state.

Centennial Valley, August 16, 1895 (No. 1674).

Lactuca Ludoviciana, D C. Prodr. vii, 141 (1838).

Rare; possibly confined to the eastern part of the state.

Laramie Peak, August 7, 1895 (No. 1596).

Lactuca pulchella, D C. Prodr. vii, 134 (1838).

Very frequent in the fertile soil of valleys.

Blue Grass Creek, July 13, 1894 (No. 445); Laramie, September 16, 1894 (No. 1146).

Sonchus asper, (L.) All. Fl. Ped. i, 222 (1785).

This has found its way into several parts of the state; Lander, August 3, 1894 (No. 872); Evanston, September 1, 1894, sent by Dr. Solier

Lygodesmia grandiflora, T. & G. Fl. ii, 485.

Very rare; some specimens by B. C. Buffum from near Tie Siding, July 18, 1891.

Lygodesmia juncea, Don. Edinb. Phil. Journ. vi, 311 (1829).

A "weedy" plant very common on the Laramie Plains.

University campus, September 26, 1894 (No. 1165). *Skeleton Weed.*

Stephanomeria minor, Nutt. Trans. Am. Phil. Soc. (II) vii, 427 (1841).

Ptiloria tenuifolia, (Torr.) Raf.

Probably not rare, though observed but twice.

Gros Ventre Hills, August 16, 1894 (No. 925); also a small form of it from Laramie Peak, August 24, 1895 (No. 1624).

Stephanomeria runcinata, Nutt. l. c. 428. *Ptiloria pauciflora,* (Torr.) Raf.

Infrequent; on a ridge of disintegrated rock, Garfield Peak, July 27, 1894 (No. 655).

CAMPANULACEÆ.

Campanula Parryi, Gray, Syn. Fl. Suppl. 395.

Rare; probably confined to the high, grassy valleys of the southern part of the state.

Cummins, July 31, 1894 (No. 1495).

Campanula rotundifolia, L. Sp. Pl. 163 (1753).

One of the very commonest plants in all our hills and mountains, at least where a reasonable amount of moisture is to be found.

Cold Springs, July 14, 1894 (No. 448); Union Pass, August 11, 1894 (No. 814); Cummins, August 1, 1895 (No. 1540). *Blue Bell.*

Specularia perfoliata, A. DC. Mon. Camp. 351 (1830). *Legouzia perfoliata,* (L.) Britton.

Not infrequent in the eastern part of the state.

Whalen Canon, July 18, 1894 (No. 514); Laramie Peak, August 8, 1895 (No. 1657).

ERICACEÆ.

Vaccinum cæspitosum, Michx. Fl. Bor. Am. i, 234 (1803).

Very abundant in the Medicine Bow Mountains and producing the small, sweet berries in profusion.

Centennial Hills, August 18, 1895 (No. 1728). *Blueberry.*

Vaccinum Myrtillus, L. Schk. Handb. t. 107.

In openings in the Spruce timber at high elevations; infrequent.

July 1892, by B. C. Buffum; Centennial Hills, June 9, 1895 (No. 1292).

Arctostaphylos Uva-ursi, (L.) Spreng. Syst. ii, 287 (1825).

Throughout the state, both on open and on wooded hillsides.

Laramie Hills, May 18, 1894 (No. 1214). *Kinnikinick.*

Bryanthus empetriformis, Gray, Proc. Am. Acad. vii, 377.

A beautiful alpine species; in small basin-like heath among the Spruce trees.

Union Peak, August 13, 1894 (No. 1006).

Kalmia glauca, Ait. Hort. Kew. ii, 64 t. 8 (1811).

Rare; on the margin of a little lake at 9,000 ft., Teton Mountains, August 21, 1894 (No. 952).

Pyrola chlorantha. Sw. Act. Holm. 1810, t, 5 (1810).

In deep, shaded ravines; Cummins, July 31, 1895 (No. 1505).

Pyrola minor, L. Sp. Pl. 396 (1753).

On the shaded border of a lake immediately at the base of one of the perpetual snow banks of the Medicine Bow Mountains.

La Plata Mines, August 23, 1895 (No. 1825).

Pyrola rotundifolia, L. Sp. Pl. 396 (1753).

Infrequent; Teton Mountains, August 21, 1894 (No. 947).

Pyrola rotundifolia uliginosa, Gray, Man. Ed. 2, 259 (1856). *P. uliginosa*, Torr.

Much more frequent than the species; abundant in cold, shaded, wet places in the mountains.

Centennial Hills, August 19, 1895 (No. 1729).

Pyrola secunda, L. Sp. Pl. 396 (1753).

Very abundant in deep woods, especially of high, rich valleys.

Bald Mountain, August 15, 1892; Union Pass, Augnst 10, 1894 (No. 802); Cummins, July 30, 1895 (No. 1504).

Moneses uniflora, Gray, 273 (1848).

In the densely shaded woods about a mountain lake on the Tetons, August 21, 1894 (No. 945); also by B. C. Buffum in a gulch near Bald Mountain, 1892.

Chimaphila umbellata, Nutt. Gen. i, 274 (1818).

On mountain sides in the woods or in the shade of overhanging cliffs.

Teton Mountains, August 21, 1894 (No. 946); Laramie Peak, August 6, 1895 (No. 1616).

MONOTROPACEÆ.

Pterospora Andromedea, Nutt. Gen. i, 269 (1818).

In the pine woods, frequent but not abundant.

Snake River, August 22, 1894 (No. 985); Centennial Valley, August 17, 1895 (No. 1681).

Monotropa Hypopitys, L. Sp. Pl. 387 (1753). *Hypopitys Hypopitys*, (L.) Small.

Infrequent; Centennial Hills, August 17, 1895 (No. 1708).

PRIMULACEÆ.

Primula farinosa, L. Sp. Pl. 143 (1753).

Very rare; not found by the writer, but three fine specimens received from Mr. Houghton, who collected them on the Little Laramie River, June 8, 1894 (No. 187).

Primula Parryi, Gray, Am. Journ. Sci. II, xxxiv, 257.

A very rare plant; collected by B. C. Buffum in the Wind River Mountains, July 21, 1892.

Androsace filiformis, Retz. Obs. ii, 10.

Very abundant in wet, caved in places on mountain streams.

Pole Creek, June 27, 1895 (No. 1318); La Plata Mines, August 23, 1895 (No. 1848).

Androsace occidentalis, Pursh, Fl. Am. Sept. 137 (1814),

Common on dry creek banks, especially in cattle wallows where other vegetation has been killed.

Horse Creek, June 9, 1894 (No. 194); Centennial Valley, June 8, 1895 (No. 1244)

Androsace septentrionalis, Lam. Ill. t. 98, f. 2.

On moist hillsides at both the higher and the lower altitudes.

Union Pass, August 13, 1894 (No. 1030); Table Mountain, June 27, 1895 (No. 1332).

Androsace septentrionalis subumbellata, n. var.

A diminutive alpine form may receive this name. Plant only ½ to 1 inch high; leaves mostly entire; scapes few and one flowered, or, if umbelliferous only three to five; calyx shorter than the corolla, its lobes noticeably shorter than its tube.

On a grassy hillside near the summit of Union Peak, August 13, 1894 (No. 998).

Dodecatheon Meadia, L. Sp. Pl. 144 (1753).

On the partly shaded banks of small brooklets in the Laramie Hills.

Pole Creek, June 27, 1895 (No. 1329).

Dodecatheon pauciflorum, Greene.

The wet meadows in the Laramie River bottoms, in some places, are so densely covered with this plant that at a distance they suggest immense lakes of purplish-blue water. June 19, 1894 (No. 268); Centennial Valley, June 9, 1895 (No. 1312).

Dodecatheon, sp.

Some very small specimens secured by B. C. Buffum at Bald Mountain, with single flowered scapes. probably belong to the var. *alpina*, Gray, of *D. Meadia.* August 8, 1892.

Steironema ciliatum, Baudo, Ann. Sci. Nat. (II) xx, 346 (1843).

Rich soil in thickets on streams.

Laramie Peak, August 7, 1895 (No. 1582); Bald Mountain, August, 1892.

Glaux maritima, L. Sp. Pl. 148 (1753).

On the low, wet shores of alkali ponds and lakes; abundant.

Laramie, June 16, 1894 (No. 248).

OLEACEÆ.

Fraxinus viridis, Michx. f. Hist. Arb. 3: 115, t. 10 (1813). *F. lanceolata*, Borck.

Rare in the parts of the state collected.

Platte River, July 14, 1894 (No. 480).

APOCYNACEÆ.

Apocynum androsæmifolium, L. Sp. Pl. 213 (1753).

Frequent on grassy slopes in the foothills of the Platte.

Whalen canon, July 19, 1894 (No. 535); Laramie Peak, August 7, 1895 (No. 1632).

Apocynum cannabinum, L. Sp. Pl, 213 (1753).

Rare in the districts collected, but probably frequent in the north-east.

On the banks of the Platte, July 11, 1894 (No. 396); also on the Big Muddy, July 23, 1894 (No. 596).

ASCLEPIADACEÆ.

Acerates viridiflora linearis, Gray, Syn. Fl. 2.

Rare; occasional specimens on the banks of the Platte River.

Fairbanks, July 14, 1894 (No. 489).

Asclepias cryptoceras, Watson, King's Rep. (1871).

This is a rare plant, coming into our range only in the western part.

Snake River, May 29, 1892, by Fred McCoullough.

Asclepias Hallii, Gray, Proc. Am. Acad. viii, 69.

Infrequent: on the banks of a clayey ravine at Wood's Landing, July 31, 1895 (No. 1556).

Asclepias speciosa, Torr. Ann. Lyc. N. Y. ii, 218 (1827).

Frequent in the eastern part of the state.

Lusk, July 21, 1894 (No. 575); McGill's Ranch, on the Laramie River, August 3, 1895 (No. 1573).

Asclepias verticillata pumila, Gray, Proc. Am. Acad. xii, 71 (1876).

Rare; in a sandy canon leading to the Platte; Fairbanks, July 14, 1894 (No. 466).

GENTIANACEÆ.

Gentiana affinis, Griseb. Hook. Fl. Bor. Am. i, 56 (1834).

In wet meadows at 8,000 to 10,000 ft.

Upper Wind River, August 8, 1894 (No. 754); Snake River, August 22, 1894 (No. 960); La Plata Mines, August 22, 1895 (No. 1853).

Gentiana Amarella acuta, Hook. *G. acuta,* Michx.

In meadow lands on the Laramie River and its tributaries; very abundant.

Cummins, July 30, 1895 (No. 1543); Centennial Valley, August 25, 1895 (No. 1852).

Gentiana Amarella stricta, Watson, King's Rep. (1871).

Rare; specimens from Wolf Creek, August, 1892, by B. C. Buffum.

Gentiana calycosa, Griseb. in Hook. Fl. Bor. Am. ii, 68 (1838).

This beautiful alpine species probably in all of our higher mountains.

Tetons, August 21, 1894 (No. 1057); La Plata mines, August 22, 1895 (No. 1767).

Gentiana frigida, Hænke. Jacq. Coll. ii, 13.

As rare as it is odd; on the shore of a small alpine lake, La Plata Mines, August 23, 1895 (No. 1804).

Gentiana humilis, Stev. Act. Mosq. iii, 258).

Frequent on the banks of small creeks in the hills and mountains.

Horse Creek, June 9, 1894 (No. 220); Centennial Valley, June 9, 1895 (No. 1313).

Gentiana Oregana, Engelm. Gray, Syn. Fl. ii, pt. i, 122 (1886).

Infrequent; in a mountain valley, at 8,000 ft.; Cummins, July, 29, 1895 (No. 1527).

Gentiana Parryi, Engelm. Trans. St. Louis Acad. ii, 218, t. 10.

Wet, subalpine valleys.

Cummins, July 29, 1895 (No. 1526); Bald Mountain, August 17, 1892.

Gentiana serrata holopetala, Gray, Bot. Cal. i, 481 (1876).

Under this name I have two quite distinct forms, neither of which is typical, but lacking salient characters enough to separate them. The one is small and simple stemmed, the other freely branched from the base. Both with unusually large showy flowers conspicuously fringed. Remarkably abundant in high, wet valleys.

Union Pass, August 10, 1894 (No. 865); Cummins, July 30, 1895 (No. 1539); Centennial Valley, August 17, 1895 (No. 1725); La Plata, August 21, 1895 (No. 1766).

Gentiana tenella, Rottb. Act. Haffn. x, 436, t. 2.

Rare; Cummins, July 27, 1895 (No. 1518).

Pleurogyne rotata, Griseb. Gent. 309 (1839).

Very rare; on the hummocks in a swampy meadow, Centennial Valley, August 18, 1895 (No. 1701).

Swertia perennis, L. Sp. Pl. i, 226 (1753).

In subalpine meadow swamps; frequent.

Union Pass, August 13, 1894 (No. 988); Centennial Hills, August 20, 1895 (No. 1742),

Frasera speciosa, Dougl. Hook. Fl. Bor. Am. ii, 66 (1838).

By reason of its size, a conspicuous and characteristic object both on the timbered and denuded mountain slopes.

Wind River Mountains, August 12, 1894 (No. 935); Laramie Peak, August 6, 1895 (No. 1609).

POLEMONIACEÆ.

Phlox bryoides, Nutt. Journ. Acad. Phila. II. i, 153 (1848).

This is very abundant on rather naked limestone ridges where they crop out on the Laramie Plains and in the foothills. May 25, 1894 (No. 67); June 7, 1895 (No. 1280).

Phlox cæspitosa, Nutt. Journ. Acad. Phila. vii, 41 (1834).

One of the earliest flowers on the plains; very abundant; pink flowered forms are common.

Laramie, May 12, 1894 (No. 8), and at various other times.

Phlox Douglasii, Hook. Fl. Bor. Am. 2: 73, t. 158 (1834).

On the sides of dry, sandy ravines and ridges; infrequent.

Uva, July 10, 1894 (No. 397); also from Beaver Divide, July, 1891.

Phlox longifolia, Nutt. Journ. Acad. Phila. vii, 41 (1834).

Leaves mostly less than an inch in length, otherwise the plant seems typical; very abundant in the Laramie Hills; June 7, 1894 (No. 182), and at several other times.

Phlox longifolia brevifolia, Gray.

Specimens perfectly in accord with description in Syn. Fl. were obtained at La Plata Mines, August 24, 1894 (No. 1827).

Phlox nana, Nutt. Pl. Gamb. 153.

If this determination is right, which it is if the descriptions go for anything, this extends the range of this plant quite a little.

Collected on Snake River, May 29, 1892, by Fred McCoullough.

Gilia aggregata, Spreng. Syst. i, 626 (1825).

Widely distributed, but never in any great abundance; Beaver Creek, July 17, 1892; Bell Springs, July 4, 1891; Snake River, August 22, 1894 (No. 961).

Gilia aggregata attenuata, Gray, Syn. Fl. II, i, 145 (1886).

On an abrupt, stony, gravelly bank of the Laramie River. Cummins, July 29, 1895 (No. 1522).

Gilia Breweri, Gray, Proc. Am. Acad. viii, 266.

Infrequent; possibly confined to the Pacific slope.

Gros Ventre River, August 18, 1894 (No. 1094).

Gilia gracilis, Hook. Bot. Mag. t, 2924 (1829).

Very abundant on the rich sandy loam of the small valleys of the Laramie Hills and in similar locations throughout the state.

Pole Creek, June 2, 1894 (No. 107); Inyan Kara Divide, August 30, 1892.

Gilia inconspicua, Sweet, Hort. Brit. 286 (1826).

Thus far only from the Big Wind River, August 3, 1892, by B. C. Buffum; August 5, 1894 (No. 709).

Gilia inconspicua sinuata, Gray, Proc. Am. Acad. viii, 278.

This extends the range of this plant northward somewhat; in the sandy bed of a dry creek; Muskrat July 30, 1894 (No. 683).

Gilia linearis, Gray, Proc. Am. Acad. xvii, 223 (1882). *Collomia linearis*, Nutt.

This is by far the most frequent of our Gilias, common in the rich loam along streams everywhere.

Pole Creek, June 2, 1894 (No. 108); Sybille Creek, July 8, 1894 (No. 401).

Gilia minima, Gray, Proc. Am. Acad. viii, 269 (1880). *Navarretia minima*, Nutt.

Not found on the Atlantic slope.

Silver Creek, August 26, 1894 (No. 1129).

Gilia nudicaulis, Gray, Proc. Am. Acad. viii, 266 (1870).

The type locality is in the western part of this state, and the plant is probably common throughout the state, but so small and inconspicuous as usually to be passed over.

Horse Creek, June 9, 1894 (No. 193).

Gilia Nuttallii, Gray, Proc. Am. Acad. viii, 267 (1870).

An undoubted specimen of this species without data, by B. C. Buffum, in 1892. Probably near Bald Mountain, August, 1892.

Gilia spicata, Nutt. Journ. Acad. Phil. (II) i, 156 (1848).

Frequent about the sand dunes in the foothills.

Pass Creek, June 20, 1892; Laramie Hills, June 7, 1894 (No. 175). My number 259 approaches *G. spicata capitata*, Gray, pretty closely, but I do not think it typical.

Polemonium confertum, Gray, Proc. Acad. Phila. 1863, 63 (1863),

A beautiful alpine plant on grassy or rocky slopes.

Union Peak, August 13, 1894 (No. 991); La Plata Mines, August 22, 1895 (No. 1823).

Polemonium confertum mellitum, Gray, l. c.

In crevices and on ledges on the higher rocky summits of the Laramie Mountains.

Richardson's Peak, June 9, 1894 (No. 208); Laramie Peak, August 7, 1895 (No. 1625).

Polemonium humile pulchellum, Gray, Syn. Fl. II. i, 150 (1886).

What seems to belong here was secured by B. C. Buffum in 1892; no other data.

Polemonium occidentale, Greene. Pittonia ii, 75 (1890).

Name communicated by Prof. Greene. Rare; in spring bog on Muddy Creek, August 25, 1894 (No. 1104).

HYDROPHYLLACEÆ.

Hydrophyllum occidentale, Gray, Proc. Am. Acad. x, 314.

This, I am sorry to say, I have distributed as *H. Virginicum*,—a piece of carelessness, for the specimens plainly enough belong here.

Very abundant in the copses on our streams.

Pole Creek, June 2, 1894 (No. 89); Table Mountain, June 29, 1895 (No. 1408).

Ellisia Nyctelea, L. Sp. Pl. Ed. 2, 1662 (1763). *Macrocalyx Nyctelea*, Kuntze.

On dry loam soil on creek banks; observed only on the east slopes of the Laramie range.

Table Mountain, June 27, 1895 (No. 1350).

Phacelia circinata, Jacq. Eclog. 135 t. 91.

Of the synonomy and citations applicable to my specimens, I am in doubt, but all answer to the above in Syn. Fl. II. i, 159.

Inyan Kara Divide, August 30, 1892; Union Peak, August 14, 1894 (No. 1082); Pole Creek, June 26, 1895 (No. 1323).

Phacelia Franklinii, Gray, Man. Ed. 2, 329 (1856).

This gives one more locality for the range of this plant.

Bacon Creek, August 15, 1894 (No. 914).

Phacelia glandulosa, Nutt. Fl. Gambl. 160.

Infrequent and scattering; Pole Creek, June 30, 1895 (No. 1361); also noted at Cummins.

Phacelia Menziesii, Torr. Watson, King Rep. 252.

These handsome specimens were sent to us from Snake River, May 29, 1892, Fred McCoullough.

Phacelia sericea, Gray, Am. Journ. Sci. ser. 2, (1862) xxxiv, 254.

Very common in moist, partly shaded ground in the hills and along streams.

Pole Creek, June, 2, 1894 (No. 102); a white flowered form from the Centennial Valley, June 9, 1895 (No. 1283).

Phacelia sp.

A small annual having affinities with both *P. circinata*, and *P. Franklinii*, must for the present be passed over.

Sybille, July 8, 1894 (No. 318).

BORAGINACEÆ.

Coldenia Nuttallii, Hook. Kew. Journ. Bot. iii, 296 (1851).

In a sandy canon or valley leading to the Big Wind River, August 6, 1894 (No. 719); observed in no other locality.

Echinospermum floribundum, Lehm in. Hook. Fl. 2: 84, t. 164 (1834). *Lapula floribunda*, Greene.

Growing almost at the water's edge on some of the streams in the eastern part of the state.

Sybille Creek, July 7, 1894 (No. 348); Pole Creek, June 29, 1895 (No. 1367).

Echinospermum Lapula, Lehm. Asperif. 121 (1818). *Lapula Lapula*, (L.) Karst.

This weed seems to have found its way into waste places about town.

Laramie, June 17, 1891; also at Uva, July 10, 1894 (No. 424).

Echinospermum Redowskii occidentale, Watson, King's Exp. 246 (1871). *Lapula Texana*, (Scheele) Britton.

Common everywhere; Laramie, June 28, 1894 (No. 294); Blue Grass Hills, July 8, 1894 (No. 305).

Echinospermum Redowskii cupulatum, Gray, in Brew. & Wats. Bot. Cal. i, 530 (1876).

This, I note, has been reduced to the same as the preceding, but to say the least there is a marked difference between the nutlets.

By B. C. Buffum, in the northeastern part of the state, August 19, 1892.

Allocarya Nelsonii, Greene, Erythea iii, 48 (1895).

The original description is as follows: "Annual, diffuse, the stoutish and somewhat succulent branches strigose-pubescent, six inches long, rather densely racemose throughout and with a short bract subtending each pedicel; nutlets ¾ line long, ovate-lanceolate, carinate ventrally almost down to the nearly basal rounded or obscurely trigonous scar, the back with rather few and sharp

transverse ridges beset with tufts of uncinate-tipped bristles, the intervals with low, muriculate-roughened tuberculations."

Only one small patch of these plants observed; they had taken possession of a few depressions, possibly old buffalo wallows, on bottom land near Silver Creek, August 26, 1894 (No. 1198).

Allocarya scopulorum, Greene, Pitt. i, 16 (1887).

Rather infrequent; Upper Wind River, August 10, 1894 (No. 768); Centennial Valley, August 25, 1895 (No. 1850).

Krynitzkia Californica subglochidiata, Gray, Bot. Cal. i, 526.

Common on dry loam soil near streams.

Cooper Creek, June 19, 1892; Table Mountain June 28, 1895 (No. 1311).

Krynitzkia crassisepala, Gray, Proc. Am. Acad. xx, 268 (1885). *Cryptanthe crassisepala,* (T. & G.) Greene.

Frequent on sandy plains.

Laramie, August 8, 1891; Blue Grass Creek, July 8, 1894 (No. (304).

Krynitzkia Fendleri, Gray, l. c. *Cryptanthe Fendleri,* (Gray) Greene.

Infrequent; Cummins, July 25, 1895 (No. 1523).

Krynitzkia fulvocanescens, Gray, Proc. Am. Acad. xx, 280 (1885). *Oreocarya fulvocanescens,* (Gray) Greene.

Fine specimens of this were secured by Prof. Buffum, at Cooper Creek, June 18, 1892.

Krynitzkia glomerata, Gray, Proc. Am. Acad. xx, 279 (1885). *Oreocarya glomerata,* (Gray) Greene.

This is perhaps our commonest Krynitzkia; frequent on dry hill-sides, railroad embankments and on the plains.

Laramie, July 8, 1894 (No. 418); Table mountain, June 30, 1895 (No. 1362); a very large, coarse form from Uva, July 10, 1894 (No. 388).

Krynitzkia glomeriflora, Greene.

Frequent in dry, rich loam soil along streams.

Pole Creek, near Table Mountain, June 2, 1894 (No. 152); Centennial Valley, June 9, 1895 (No. 1335).

Krynitzkia Jamesii, Gray, Proc Am. Acad. xx, 277. *Oreocarya suffruticosa,* Greene.

Infrequent; in canons near the Platte River, July 14, 1894 (No. 477).

Krynitzkia Pattersoni, Gray, Proc. Am. Acad. xx, 278.

Rare; in the Laramie Hills, July 7, 1894 (No. 412).

Krynitzkia sericea, Gray, Proc. Am. Acad. xx, 277. *Oreocarya sericea,* Greene.

Frequent on rocky slopes in the Laramie Hills; June 16, 1894 (No. 255); Uva, July 10, 1894 (No. 389).

Krynitzkia virgata, Proc. Am. Acad. xx, 279.

Frequent on sandy ridges in the foothills.

Telephone canon, June 15, 1894 (No. 231); Centennial Valley, June 9, 1895 (No. 1267).

Krynitzkia Watsoni (?) Gray, Proc. Am. Acad. xx, 270.

These are somewhat doubtfully placed here; collected on wet, shaded rocky ledges in the Centennial Hills, August 17, 1895 (No. 1684).

Mertensia alpina, Don. Syst. iv, 320.

Strictly alpine from a climatic point of view, but hardly so from that of altitude; very early in the Laramie Hills while freeziug nights are still the rule; often in blossom by April 20. (Nos. 33 and 1222).

Mertensia lanceolata, DC. Prodr. x, 88 (1846).

Very variable as to size and general appearance, but floral characters and the light-green glaucus color constant. It is abundant and frequent in our foothills in two forms: a small form from large, coarse rootstocks, very early, radical leaves few, stem leaves nearly uniform, panicle close and leafy; a much larger form later in the season, usually in copses, stem leaves gradually reduced in size, panicle long and open. 1, Laramie Hills, May 16, 1894 (No. 34); 2, Pole Creek, June 28, 1895 (No. 1234).

Mertensia lanceolata viridis, n. var.

Root stocks slender, creeping in the crevices among the rocks; radical leaves numerous, long and slender petioled, from oblong to elliptical; cauline leaves oblong, gradually reduced in size; stems few and slender, 5-8 inches high, bearing an open panicle; floral characters those of the species, except that the corolla tube is wider and shorter. *Mertensia lanceolata,* DC.

This plant is alpine in habitat and may be known by the bright green color of its leaves, which are scarcely scabro-puberulent under a lens.

On rocky ledges near the summit of Laramie Peak, August 7, 1895 (No. 1608).

Mertensia sibirica, Don. Syst. iv, 320.

Quite a large series of specimens from many localities and different altitudes, and of very different general appearance, have all been reduced to this. Environment produces greater differences than is usually conceded. Wet places, along streams and in the mountains; Sybille, July 8, 1894 (No. 408); Garfield Peak, July 29, 1894 (No. 689); Union Pass, August 13, 1894 (No. 1031) and other localities.

Myosotis sylvatica alpestris, Koch.

This beautiful little plant is found in abundance in the alpine regions of our northern mountains. Little Bald Mountain, August 15, 1892 B. C. Buffum; Union Pass, August 11, 1894 (No. 838).

Onosmondium molle, Michx. Fl. Bor. Am. I: 133, t. 15 (1803).

Rare and probably confined to the eastern part of the state. Orin Junction, August 1892; Platte River, July 14, 1894 (No. 506).

Lithospermum angustifolium, Michx. Fl. Bor. Am. i, 130 (1803).

Very common on the plains and in the mountain valleys. University Campus, June 4, 1894 (No. 174); in its fruiting form July 23, 1895 (No. 1428).

Lithospermum pilosum, Nutt. Journ Acad. Phil. vii, 43 (1834).

Much less frequent than the preceding; Middle Pass, June 20, 1892; Gros Ventre River, August 18, 1894 (No. 1090).

CONVOLVULACEÆ.

Ipomea leptophylla, Torr. in Frem. Rep. 95 (1845).

Abundant in the eastern part of the state on the Platte and in the adjacent foothills

Fort Laramie, September 3, 1892; Fairbanks, July 14, 1894 (No. 491).

Convolvulus sepium, L. Sp. Pl. 153 (1753).

Collected by B. C. Buffum, August 1, 1891, probably at Cheyenne. Rare in the state.

Evolvulus argenteus, Pursh Fl. Am. Sept. 187 (1814). *E. Nuttallianus*, R. & S.

Infrequent; dry plains near Uva, July 10, 1894 (No. 398); also at Sheridan, September, 1895.

Cuscuta decora, Engelm. Trans. St. Louis Acad. i, 501 (1859). *C. indecora,* Choisy.

Parasitic on *Alfalfa,* Sheridan Experiment Farm, August 19, 1892.

Cuscuta epilinum, Weihe. Archiv. Apoth. viii. 54 (1824).

On *Alfalfa,* Laramie Experiment Farm, July, 1894 (No. 1210).

SOLANACEÆ.

Solanum rostratum, Dunal. Sol. 234, t. 24 (1813).

Probably abundant on the eastern border.

Fort Laramie, September 5, 1892; Whalen Canon, July 18, 1894 (No. 527). Not yet reported as a bad weed in any locality.

Solanum triflorum, Nutt. Gen. i, 128 (1818).

Particularly annoying as a weed in garden and "truck" patches; small plants, such as *Carrots* and *Parsnips,* must be "weeded" by hand or this weed will completely smother them.

Experiment Farm, September 15, 1894.

Physalis lanceolata, Michx. Fl. Bor. Am. i, 149 (1803).

This genus seems to be confined to the lower altitudes of the north and east; rather plentiful on the Platte and adjoining foot-hills.

A large form of this species from Blue Grass Hills, August 8, 1894 (No. 365); also a small and more pubescent form from the same place (No. 295).

Physalis lanceolata lævigata, Gray, Proc. Am. Acad. x, 62.

Infrequent; in a canon near the Platte at Fairbanks, July 14, 1894 (No. 478).

SCROPHULARIACEÆ.

Scrophularia Marylandica, L. Sp. Pl. 619 (1753).

Our specimens are far from typical; the thyrsus very narrow, the separate cymes simple; leaves large and truncate at base.

Sybille, July 8, 1894 (No. 317); Pole Creek, June 30, 1895 (No. 1410). Specimens from Garfield Peak, July 29, 1894 (No. 690) have large deltoid-cordate leaves even to the summit of the stem; infloresence only a simple cyme.

Pentstemon acuminatus, Dougl. Lindl. Bot. Reg. t. 1285 (1829).

Abundant in the Laramie range in the foothills, on stony slopes.

Laramie Hills, June 7, 1894 (No. 180); Table Mountain, June 28, 1895 (No. 1325).

Pentstemon cæruleus, Nutt. Gen. ii, 52 (1818).

Frequent on the Laramie Plains, especially on sandy ridges bordering on the Laramie River; June 7, 1894 (No. 179); June 18, 1895 (No. 1308).

Pentstemon cæspitosus, Nutt. Gray, Proc. Am. Acad. vi, 66.

A few good specimens of this rather rare plant from Wheatland, June 11, 1892, by B. C. Buffum.

Pentstemon confertus cæruleo-purpureus, Gray, Proc. Am. Acad. vi. 72.

Frequent on subalpine grassy slopes, and much reduced specimens from alpine locations.

Saratoga July 17, 1892; Union Pass, August 11, 1894 (No. 833); Union Peak, August 13, 1894 (No. 1017).

Pentstemon cristatus, Nutt. Gen. ii, 52 (1818).

Common in sandy ravines in the foothills of the Laramie range and probably elsewhere.

Telephone Canon, June 15, 1894 (No. 235); Pole Creek, June 28, 1895 (No. 1346).

Pentstemon glaber, Pursh, Fl. Am. Sept. 738 (1814).

Infrequent and usually only scattering plants.

Sybille, July 8, 1894 (No. 327); Cottonwood Canon, August 4, 1895 (No. 1566).

Pentstemon glaber Utahensis, Watson, Bot. King Surv. 217 (1871).

Slightly variant, but I believe true specimens of this were obtained in three localities: Gros Ventre River, August 18, 1894 (No. 1093); Cummins, July 30, 1895 (No. 1541); Cottonwood Canon, August 4, 1895 (No. 1579).

Pentstemon glaucus, Graham, Edinb. Phil. Journ. 1829, 348.

Herbarium specimens fail to do justice to this singularly beautiful plant, as shape and color are both largely lost. It occurs in the alpine region of all our ranges.

Tetons, August 21, 1894 (No. 1001); Laramie Peak, August 7, 1895 (No. 1619); La Plata Mines, August 22, 1895 (No. 1792).

Pentstemon humilis, Nutt.

Exceedingly abundant in the Laramie range at the foot of rocky ledges and in stony ravines.

Pole Creek, June 2, 1894 (No. 131); Table Mountain, June 27, 1895 (No. 1322).

Pentstemon laricifolius, Hook. & Arn. Bot. Beechy. 376.

Abundant on stony ridges on the Laramie Plains and their foothills. July 7, 1894 (No. 419); July 27, 1895 (No. 1442).

Pentstemon secundiflorus, Benth. DC. Prodr. x, 324.

Infrequent; specimens by Mr. Hartley from near Sherman, July 9, 1891.

Pentstemon strictus, Benth. DC. Prodr. x, 324.

In stony ravines in the hills; Sybille, July 8, 1894 (No. 402); Cummins, July 28, 1895 (No. 1472).

Collinsia parviflora, Lindl. Bot. Reg. t. 1082 (1827).

Very abundant in sandy loam soil on creek banks.

Pole Creek, June 2, 1894 (No. 46); Centennial Valley, July 17, 1895 (No. 1685).

Mimulus alsinoides, Benth. DC. Prodr. x, 351.

Centennial Hills, August 17, 1895 (No. 1683).

Mimulus floribundus, Lindl. Bot. Reg. xiv, t. 1125 (1828).

Infrequent: good, but diminutive; from a wet ravine near Cummins, July 28, 1895 (No. 1515).

Mimulus glabratus Jamesii, Gray, Syn. Fl. Suppl. 447.

Infrequent; Whalen Canon, July 19, 1894 (No. 543).

Mimulus Langsdorfii Tilingi, Greene, Journ. Bot. for Jan., 1895.

Our commonest Mimulus; springy places in the hills and mountains.

Garfield Peak, July 29, 1894 (No. 688); Centennial Valley, August 16, 1895 (No. 1670).

Mimulus Lewisii, Pursh, Fl. ii, 427 (1814).

On stony, wet ground near creeks; infrequent.

Teton Mountains, August 21, 1894 (No. 942); Centennial Valley, August 16, 1895 (No. 1672).

Mimulus rubellus, Gray, Bot. Mex. Bound. 116.

Rare, or at least rarely observed; our plants small and inconspicuous.

On a naked, gravelly hillside, Centennial, June 9, 1895 (No. 1287).

Synthyris plantaginea, Benth. DC. Prodr. x, 455 (1846).

Some specimens from the Teton Mountains are doubtfully placed here. August 21, 1894 (No. 986).

Synthyris rubra, Benth. l. c. *Wulfenia rubra,* (Hook.) Greene.

Of very frequent occurrence in sage brush valleys; variable as to foliage.

Telephone Canon, May 12, 1894 (No. 29); Laramie Hills, June 5, 1895, (No. 1242).

Veronica alpina, L. Sp. Pl. 11 (1753).

Frequent in subalpine stations; wet, grassy slopes.

Bald Mountain, August 15, 1892; Union Pass, August 11, 1894 (No. 831); Centennial Hills, August 19, 1895 (No. 1740).

Veronica Americana, Schwein. Benth. in DC. Prodr. x, 468 (1846).

In all streams and springs.

Sybille Creek, July 8, 1894 (No. 403); noted in many other localities.

Veronica peregrina, L. Sp. Pl. 14 (1753).

In boggy places; Lander, August 3, 1894 (No. 698); Centennial Valley, August 25, 1895 (No. 1854).

Veronica serpyllifolia, L. Sp. Pl. 12 (1753).

On the grassy banks of our little mountain brooks; frequent.

Horse Creek, June 9, 1894 (No. 192).

Castilleia flava, Watson, Bot. King Surv. 230 (1871).

Of rather frequent occurrence at 7,000-8,000 ft. in the hills.

Laramie Hills, July 7, 1894 (No. 352); Table Mountain, June 27, 1895 (No. 1338).

Castilleia linariæfolia, Benth. DC. Prodr. x, 520.

Hardly subalpine; frequent on sandy, grassy slopes.

Laramie Hills, July 7, 1894 (No. 352); Laramie Peak, August 6, 1895 (No. 1570).

Castilleia miniata, Dougl. Hook. Fl. ii, 106.

I have placed here a number of specimens, some of which rather doubtfully. Most of them were secured on wet stream banks and I think the following numbers, at least, are right. Lander, August 4, 1894 (No. 742); Union Pass, August 11,1894 (No. 835).

Castilleia minor, Gray, Bot. Cal. i, 573 (1876).

Rare; observed but once. Fort Washakie, August 5, 1894 (No. 744).

Castilleia pallida, Kunth. Syn. Pl. Æquin. ii, 100.

On the shaded banks of mountain streams, at 8,000 ft. and upward.

Cummins, July 28. 1895 (No. 1461); observed at a number of other localities.

Castilleia pallida occidentalis, Gray, Bot. Cal. i, 573 (1876).

Some specimens from Union Peak I am unable to place elsewhere; August 13, 1894 (No. 1011).

Castilleia pallida septentrionalis, Gray, l. c.

Undoubted specimens of this were observed in a number of alpine and subalpine stations. This prefers the wet banks of wooded streams or the shores of alpine lakes.

Centennial Hills, August 18, 1895 (No. 1726); La Plata Mines, August 23, 1895 (No. 1808).

Castilleia parviflora, Bong. Veg. Sitch. 158 (1831).

Most frequent and earliest; in sandy loam soil among the sage brush.

Pole Creek, June 2, 1894 (No. 120); Centennial Valley, June 9, 1895 (No. 1291).

Orthocarpus luteus, Nutt. Gen. ii, 56 (1818).

Frequent in wet, sandy soil, especially along streams.

Whalen Canon, July 16, 1894 (No. 534); Lander, August 3, 1894 (No. 741); Cummins, July 30, 1895 (No. 1537).

Orthocarpus pallescens, Gray, Am. Journ. Sci. ser. 2, xxxiv, 339.

From type locality, probably not far from the place where Parry collected it.

Gros Ventre River, August 15, 1894 (No. 900).

Orthocarpus pilosus, Watson, Bot. King Surv. 231 (1871).

This rare plant, determined for me by Dr. Rose, was collected by B. C. Buffum, on Three Mile Creek, June 20, 1892.

Cordylanthus ramosus, Nutt. Gen. ii, 57 (?).

Very abundant on the alkali-clay hills adjacent to the Wind River; at Dubois, August 10, 1894 (No. 711).

Pedicularis bracteosa, Benth. Hook. Fl. ii, 110 (1838).

Probably confined to our northwest areas.

Union Pass, August 11, 1894 (No. 834).

Pedicularis crenulata, Benth. DC . Prodr. x, 568.

Abundant; growing in clumps in high meadow lands.

Laramie, June 19, 1892; Cummins, July 30, 1895 (No. 1528).

Pedicularis Grœnlandica, Retz. Fl. Scand. Ed. 2, 145 (1795).

Frequent and abundant on subalpine mountain streams.

Warm Spring Creek, August 10, 1894 (No. 806); Centennial Hills, August 19, 1895 (No. 1739).

Pedicularis Parryi, Am. Journ. Sci. ser. 2, xxxiii, 250.

Probably rare; a few specimens only, from Union Peak, August 13, 1894 (No. 1033).

Pedicularis procera, Gray, Am. Journ. Sci. ser. 2, xxxiv, 251.

Rare; in a wooded canon leading to the Laramie River, at Cummins, July 30, 1895 (No, 1550).

Pedicularis racemosa, Dougl. Hook. Fl. ii, 108 (1838).

This comes as near as any to marking a zonal belt; encountered at about 9,000 ft. in all our mountain ranges visited, and found up to timber line.

Bald Mountain, August 17, 1892; Union Pass, August 11, 1894 (No. 830); noted at Laramie Peak and in the Medicine Bow Mountains.

OROBANCHACEÆ.

Aphyllon fasciculatum, Gray, Syn. Fl. 2; Part 1, 312 (1878). *Thalesia fasciculata*, Britton.

Frequent and occasionally abundant.

Pine Creek, July 18, 1892; Pole Creek, July 1, 1895 (No. 1360), hosts,—*Artemisia frigida* and *A. Canadensis.*

Aphyllon uniflorum, T. & G. Gray, Man. 290 (1848).

Rare; Gros Ventre River, August 22, 1894 (No. 1071), host not noted.

VERBENACEÆ.

Lippia cuneifolia, Steud. Torr., in Marcy's Rep. 293, t. 17 (1853).

Laramie River bottom lands near Uva; not observed elsewhere. July 10, 1894 (No. 387).

Verbena bracteosa, Michx. Fl. Bor. Am. ii, 13 (1803).

This is a weedy plant, thriving equally well in cultivated and uncultivated grounds.

Blue Grass Hills, July 8, 1894 (No. 320); Laramie Peak, August 8, 1895 (No. 1652).

Verbena stricta, Vent. Hort. Cels, t. 53 (1800).

Probably frequent in the lower altitudes of the northeast; not observed except in the Platte Valley, near Fairbanks, July 14, 1894 (No. 505). A form with several large spikes was obtained in Whalen Canon, July 18, 1894 (No. 538).

LABIATÆ.

Mentha Canadensis, L. Sp. Pl. 576 (1753).

Frequent on all water courses and about springs.

Whalen Canon, July 18, 1894 (No. 546); specimens from a large number of other localities.

Lycopus lucidus, Turcz. Benth. in DC. Prodr. xii, 178 (1848).

Infrequent; Popo Agie River, August 2, 1894 (No. 735).

Lycopus sinuatus, Ell. Bot. S. C. and Ga. i, 126 (1816).

Wet grounds about springs and ponds; frequent.

Laramie, July, 1891; Whalen Canon, July 19, 1894 (No. 542).

Hedeoma Drummondii, Benth. Lab. Gen. and Sp. 368 (1834).

Occasional in dry loam soil.

Whalen Canon, July 19, 1894 (No. 548).

Hedeoma Reverchoni, Gray, Syn. Fl. 363.

Rare; its collection in this state extends the range of this plant northward very much; good specimens from Pole Creek, June 30, 1895 (No. 1374).

Salvia lanceolata, Willd. Enum. 37 (1809).

Only occasionally on rather dry hillsides and plains.

Blue Grass Hills, July 9, 1894 (No. 374); Centennial Valley, August 20, 1895 (No. 1395).

Monarda fistulosa, L. S. Pl. 22 (1753).

Probably confined to the eastern portion of the state; thus far noted only in the region east of Laramie Peak.

Fairbanks, July 14, 1894 (No. 508); Cottonwood Canon, August 4, 1895 (No. 1577).

Lophanthus urticifolius, Benth. Bot. Reg. xv, sub. t. 1282 (1829).
Vleckia urticifolia, (Benth.) Holzinger.
Very rare; possibly only in the northwest.
Snake River, August 22, 1894 (No. 984)

Dracocephalum parviflorum, Nutt. Gen. ii, 35 (1818).
Principally in abandoned fields.
Sybille Creek, July 8, 1894 (No. 326); Laramie Peak, August 8, 1895 (No. 1648).

Scutellaria galericulata, L. Sp. Pl. ii, 599 (1753).
Not infrequent in wet places.
Fairbanks, July 13, 1894 (No. 470); Centennial Valley, August 20, 1895 (No. 1760).

Scutellaria resinosa, Torr. Ann. Lyc. N. Y. ii, 232 (1827).
On abrupt banks along streams, but in comparatively dry ground.
Pole Creek, June 2, 1894 (No. 94); June 29, 1895 (No. 1365).

Brunella vulgaris, L. Sp. Pl. 600 (1753).
Very infrequent in the parts of the state collected
Specimens from Wolf Creek, August 18, 1892, B. C. Buffum.

Physostegia parviflora, Nutt. Benth. in DC. Prodr. 12, 434 (1848).
On the borders of lakes and ponds, growing even in the edge of the water.
Bull Lake, August 8, 1894 (No. 732); Laramie River, near Ione Ranch, August 10, 1895 (No. 1666).

Stachys palustris, L. Sp. Pl. 580 (1753).
Frequent on sandy creek banks which are covered with undershrubs and weedy plants.
Wind River, August 8, 1894 (No. 857); Cummins, July 28, 1895 (No. 1484); noted in many other places.

PLANTAGINACEÆ.

Plantago eriopoda, Torr. Ann. Lyc. N. Y. ii, 237 (1827).
Common on wet alkali flats about Laramie and in similiar locations elsewhere; June 1, 1894 (No. 42). *Plantain.*

Plantago lanceolata, L. Sp. Pl. 113 (1753).
A recently introduced weed on the Lander Experiment Farm; September, 1895, by J. S. Meyer.

Plantago major, L. Sp. Pl. 112 (1753).

Received from Sheridan as one of the weeds upon the Experiment Farm, September, 1895, by J. F. Lewis.

Some specimens from Wolf Creek, apparently native there, collected August 8, 1892, by B. C. Buffum, are doubtfully placed here. Spike very slender and leaves almost acute.

Plantago Patagonica gnaphalioides, Gray, Man. Ed. 2, 269 (1856). *Plantago Purshii*, R. & S.

Frequent on dry, gravelly hillsides in the Laramie range. Observed only in the eastern part of the state.

Laramie, August, 1891; Wheatland, July, 1891; Table Mountain, June 28, 1895 (No. 1356).

Plantago Tweedyi, Gray, Syn. Fl. II, Part i, 390 (1886).

Three specimens only of this very rare plant were secured on a grassy hillside near the La Plata Mines, August 21, 1895 (No. 1798).

I am not aware that any other specimens have been collected since it was originally collected on the Yellowstone River by Mr. Frank Tweedy.

Oxybaphus angustifolius, Sweet. Hort. Brit. 429 (1830). *Allionia linearis*, Pursh.

Never abundant, only scattering specimens, often in cultivated ground.

Wheatland, July 9, 1894 (No. 379); Cottonwood Canon, August 4, 1895 (No. 1560); also from Sheridan, September, 1895.

Oxybaphus hirsutus, Choicy in DC. Prodr. xiii, part 2, 433 (1849). *Allionia hirsuta*, Pursh.

Rare; noted but once; Whalen Canon, July 18, 1894 (No. 515).

Oxybaphus nyctagineus, Sweet. Hort. Brit. 429 (1830). *Allionia nyctaginea*, Michx.

Very rare, unless it be in the northeastern part of the state.

Fairbanks, July 14, 1894 (No. 469).

Abronia fragrans, Nutt. Hook. Kew. Journ. Bot. v, 261 (1853).

Frequent on the sandy plains of the eastern part of the state.

Inyan Kara Divide, August 29, 1892; Platte River, July 14, 1894 (No. 464); Cummins, July 28, 1895 (No. 1473).

Abronia micrantha, Torr.

Very rare; on the plains and hillsides; by children called the *Sand Flower.*

Near Willow Creek, July 22, 1894 (No. 630).

ILLECEBRACEÆ.

Paronychia Jamesii, T. & G. Fl. N. A. i, 170 (1838).

Frequent on dry, open slopes in the Laramie range.

Fairbanks, July 14, 1894 (No. 451); also near Laramie Peak.

Paronychia pulvinata, Gray, Proc. Acad. Phila. 1863, 58.

Infrequent and strictly alpine; on the naked summits of the Medicine Bow Mountains, August 23, 1895 (No. 1824).

Paronychia sessiliflora, Nutt. Gen. i, 160 (1818).

Common on the slopes about Laramie Peak, August 8, 1895 (No. 1638); observed in some other localities.

Paronychia sp.

Numbers 349, 461, 1331 and 1656 have for the present been laid aside. They represent at least two species not given above, but for want of sufficient literature they are now passed over.

AMARANTACEÆ.

Amarantus albus, L. Sp. Pl. Ed. 2, 1404 (1763).

A troublesome weed in most of our fields and gardens.

Popo Agie River, August 3, 1894 (No. 740); Sheridan Experiment Farm, September 1895.

Amarantus blitoides, Wats. Proc. Am. Acad. xii, 273 (877).

This too would find a place even in a very short list of the worst weeds.

Laramie, September 24, 1894 (No. 1176); Sheridan, September, 1895.

Amarantus chlorostachys, Willd. *A. hybridus,* L.

Some specimens, apparently this, were collected by B. C. Buffum, at Inyan Kara Divide, August 30, 1892.

Amarantus retroflexus, L. Sp. Pl. 991 (1753).

Where weeds run riot this will always be found.

Laramie, October, 1893; Lander, August 3, 1894 (No. 715).

Amarantus Torreyi, Benth. Wats. Bot. Cal. ii, 42 (1880).

Infrequent; near Rawlins, June 29, 1892.

CHENOPODIACEÆ.

Cycloloma platyphyllum, Moq. Enum. Chenop. 18 (1840). *C. atriplicifolium*, Coulter.

Frequent in the sandy canons leading to the Platte, near Fairbanks, July 14, 1894 (No 471).

Monolepsis chenopodioides, Moq. DC. Prodr. xiii, part 2, 85 (1849). *Monolepsis Nuttalliana*, Greene.

Frequent in saline ground.

Laramie, August, 1893; Boulder Creek, August 26, 1894 (No. (1103).

Chenopodium album, L. Sp. Pl. 219 (1753).

In waste and cultivated ground.

Laramie, October, 1893; Sheridan Experiment Farm, September, 1895. *Pigweed.*

Chenopodium capitatum, Watson, Bot. Cal. ii, 48 (1880).

Infrequent; leaves only, from Cummins, July 27, 1895 (No. 1448).

Chenopodium Fremontii, Watson, Bot. King's Exp. 287 (1871).

Abundant on dry hillsides and on rocky shelving ledges.

Fairbanks, July 13, 1894 (No. 440).

Chenopodium glaucum, L. Sp. Pl. 220 (1753).

Apparently indigenous in places, but scattering everywhere as a weed.

Poison Spider Creek (native ?), July 27, 1894 (No. 625); among the weeds at Laramie and Sheridan.

Chenopodium leptophyllum, Nutt. Moq. DC. Prodr. xiii, part 2, 71 (1849).

Not infrequent near the Platte and its tributaries; Laramie, August 15, 1893; Platte River, July 14, 1894 (No. 483).

Chenopodium leptophyllum subglabrum, Wats. Proc. Am. Acad. ix, 95.

Rare; Willow Creek, July 22, 1894 (No. 628).

Chenopodium olidum, Watson, Proc. Am. Acad. ix, 96.

In saline ground on Poison Spider Creek, July 27, 1894 (No. 622); also sent from the Sheridan Experiment Farm as a weed, 1895.

Chenopodium rubrum humile, Watson, Bot. Cal. ii, 48.

Some specimens from Laramie, by B. C. Buffum, June 23, 1894, seem to belong here. Not observed elsewhere.

Atriplex argentea, Nutt. Gen. i, 198 (1818).

Throughout the state; reported as a weed from some localities.

Big Muddy Creek, July 24, 1894 (No. 640); Meadow Creek, August 9, 1894 (No. 791); Sheridan, September, 1895.

Atriplex canescens, James, Wats. Proc. Am. Acad. ix, 110 (1874).

Not frequent; observed only on the east side of the Laramie range.

Wheatland, August 11, 1891; Platte Hills, Fairbanks, July 14, 1894 (No. 463).

Atriplex confertifolia, Watson, l. c.

A common shrub on the alkali deserts of the central and southwestern parts of the state. Frequently called *White Sage* and is said to be freely eaten by antelope and sheep during the winter months.

Rock Springs, September 9, 1893; Bessemer, July 26, 1894 (No. 613).

Atriplex expansa, Watson, Proc. Am. Acad. ix, 116 (1874).

Very abundant in the vicinity of alkali lakes.

Howell Lakes, October 1, 1894 (No. 1164).

Atriplex Nuttallii, Watson, l. c.

Luxuriant in strongly saline ground.

Alkali Desest, July 2, 1891; Howell Lakes, October 1, 1894 (No. 1167); alkali flats near Sweetwater River, September 10, 1894 (No. 1192).

Atriplex patula hastata, Gray, Man. Ed. 5, 409 (1867). *A. hastata.* L.

Abundant near Laramie and probably in many other localities. September 1, 1895 (No. 1866), The form with ovate entire leaves was secured at the same time.

Atriplex truncata, Gray, Proc. Am. Acad. viii, 398.

I think there is little doubt of the correctness of this reference.

Rather immature specimens from Poison Spider Creek, July 26, 1894 (No. 621); older at Howell Lakes, October 1, 1894 (No. 1166).

Eurotia lanata, Moq. Enum. Chenop. 81 (1840).

Very frequent and abundant in many localities.

Fairbanks, July 14, 1894 (No. 488); Laramie, September 12, 1894 (No. 1134).

Salicornia herbacea, L. Sp. Pl. 3 (1762).

Abundant on the shores of alkali lakes, even on the encrusted banks where nothing else will grow.

Howell Lakes, October 1, 1894 (No. 1162); Laramie, September 3, 1895 (No. 1869).

Sueda depressa, Watson, Bot. King's Exp. 294 (1871).

Not noted except at Howell Lakes, October 1, 1894 (No. 1163).

Sueda depressa erecta, Watson, Proc. Am Acad. ix, 90 (1874).

Not frequent; on an alkali bog on Poison Spider Creek, July 27, 1894 (No. 623).

Sueda diffusa, Watson, Proc. Am. Acad. ix, 88 (1874).

This is common on wet, saline ground.

Popo Agie River, August 4, 1894, (No. 717); Sheridan, September, 1895, J. F. Lewis.

Sueda Torreyana, Watson, Proc. Am. Acad. ix, 88 (1874).

Only collected at Howell Lakes, but probably elsewhere as well. October 1, 1894 (No. 1168).'

Salsola Kali Tragus, Moq. in DC. Prodr. xiii, part 2, 187 (1849).

This, the much talked of *Russian Thistle*, is already quite widely distributed in the northeastern part of the state. Other plants are frequently mistaken for it and so it has often been reported from localities in which it does not exist. There is no evidence to show that it is found on the line of the Union Pacific railroad except at Cheyenne. On the lines of the Burlington & Misssouri and the Elkhorn roads, however, I am reliably informed that it is widely distributed.

Specimens from Cheyenne, October, 1894; from Lusk and Fredericks in 1895.

Sarcobatus vermiculatus, Torr., Emory's Rep. 150 (1848).

The most characteristic shrub of the saline plains and foothills.

Sweetwater River, September 9, 1894 (No. 1182); Howell Lakes, October 1, 1894 (No. 1161). *Grease Wood.*

POLYGONACEÆ.

Eriogonum alatum, Torr. Sitgreaves Rep. t. 8 (1853).

Noted only on the foothills of the Laramie range and the adjoining plains; abundant.

Cheyenne, August 11, 1891; Laramie Hills, July 9, 1894 (No. 416).

Eriogonum annuum, Nutt. Trans. Am. Phil. Soc. (II) 5: 164 (1833-37).

Infrequent in parts of state collected.

Inyan Kara Divide, September 1, 1892; Willow Creek, July 20, 1894 (No. 566).

Eriogonum brevicaule, Nutt.

Immensely abundant throughout the state on clayey, gravelly ridges and plains.

Laramie Hills, July 8, 1894 (No. 303); Wind River, August 8, 1894 (No. 722); from several other localities.

Eriogonum cæspitosum, Nutt. Journ. Acad. Phil. vii, 50 (1834).

Very rare; Union Pass, August 14, 1894 (No. 890).

Eriogonum cernuum, Nutt. Journ. Acad. Phil. (II) 1: 162 (1848).

Widely distributed and abundant.

Laramie Hills, July 7, 1894 (No. 363); Wind River, August 8, 1894 (No. 726).

Eriogonum chrysocephalum, Gray, Proc. Am. Acad. xi, 101.

Rare; possibly confined to the Pacific Slope.

Bacon Creek, August 15, 1894 (No. 903).

Eriogonum flavum, Nutt., Fras. Cat. (1813).

Common on hillsides in the Laramie and Medicine Bow ranges.

Laramie Hills, July 8, 1894 (No. 415); Cummins, July 27, 1895 (No. 1443); a very large form with compound umbels from Laramie Peak, August 5, 1895 (No. 1572).

Eriogonum flavum crassifolium, Benth.

Frequent in the Laramie foothills. Name communicated by Dr. Robinson; citation not at hand.

Laramie Hills June 6, 1894 (No. 186).

Eriogonum heracleoides, Nutt. Journ. Acad. Phila. vii, 49 (1834).

Infrequent; our specimens are not typical but they undoubtedly must be placed here.

Wallace Creek, July 29, 1894 (No. 677).

Eriogonum microthecum, Nutt. Journ. Acad. Phila. (II) 1: 162 (1848).

Both frequent and abundant.

Laramie at various times (Nos. 329 and 1138); Sweetwater, September 12, 1894 (No. 1188).

Eriogonum ovalifolium, Nutt. Journ. Acad. Phila. vii, 50 (1834).

In dry sandy soil on the plains; frequent.

Laramie, May 29, 1894 (No. 70); Hutton ranch, June 19, 1894 (No. 278).

Eriogonum subalpinum, Greene, Pitt. xiii, part 13, 18 (1896).

This recently described species, founded, seemingly, on unimportant characters I believe to be a valid one. The eight specimens in our herbarium labelled *E. umbellatum* fall readily into the two groups made by Prof. Greene. At different times the writer has brought in the two forms from the field fully convinced that they were different and yet unable to separate them by any marked botanical characters, though so readily distinguished in the field.

Laramie Hills, July 7, 1894 (No. 346); Tetons, August 22, 1894 (No. 975); others from Laramie.

Eriogonum umbellatum, Torr. Ann. Lyc. N. Y. ii, 241 (1828).

Pole Creek, July 2, 1895 (No. 1419); Laramie Hills at various times.

Polygonum amphibium, L. Sp. Pl. 361 (1753).

Observed only in the Platte River near Fairbanks, but undoubtedly found elsewhere. July 15, 1894 (No. 551).

Polygonum aviculare, L. Sp. Pl. 362 (1753).

A common dooryard weed.

Laramie, September 24, 1894 (No. 1173). *Goose Grass.*

Polygonum bistortoides, Pursh, Fl. i, 217 (1814).

Frequent in grassy valleys.

Bald Mountain, August 15, 1892; Union Pass, August 11, 1894 (No. 1024).

Polygonum convolvulus, L. Sp. Pl. 364 (1753).

Waste and cultivated ground; Experiment Farm, September 15, 1894 (No. 1140); Popo Agie river, August 1, 1894 (No. 714).

Polygonum Douglasii, Greene, Bull. Cal. Acad, iii, 125 (1885).

In dry ravines; Sybille Creek, July 7, 1894 (No. 307); Laramie Peak, August 7, 1895 (No. 1591).

Polygonum erectum, L. Sp. Pl. 363 (1753).

Infrequent; on the bank of Blue Grass Creek, July 8, 1894 (No. 364).

Polygonum hydropiper, L. Sp. Pl. 361 (1753).

In a wet place on the banks of a small stream near Lusk, July 21, 1894 (No. 576).

Polygonum minimum, Watson, Bot. King Surv. v, 315 (1871).

I refer our specimens to this with some doubt; they are larger than the type and less pubescent.

La Plata Mines, August 24, 1895 (No. 1833)

Polygonum nodosum, Pers. Syn. i, 440 (1805). *P. lapathifolium nodosum,* (Pers.) Small.

From Wheatland, August 1892, by B C. Buffum.

Polygonum Persicaria, L. Sp. Pl. 362 (1753).

As a weed on the Sheridan Experiment Farm, September 1895, by J. F. Lewis. *Smart Weed.*

Polygonum ramosissimum, Michx. Fl. Bor. Am. i, 237 (1803).

Frequent and variable, some of the specimens approaching *P. Tenue.*

Sugg's Road, August 20, 1892; Wallace Creek, July 29, 1894 (No. 671); Green-River, August 14, 1894 (No. 888).

Polygonum viviparum, L. Sp. Pl. 360 (1753).

Frequent in the higher mountains.

Fort Laramie, September 5, 1892; Union Pass, August 11, 1894 (No. 842).

Oxyria digyna, Campd. Rum. 155, t. 3, f. 3 (1819).

Very frequent in shaded places and under overhanging cliffs, 8,000-9000 ft.

Garfield Peak, July 29, 1894 (No. 662); Laramie Peak, August 7, 1895 (No. 1620).

Rumex Crispus, L. Sp. Pl. 335 (1753).

Platte River, July 14, 1894 (No. 495); Laramie, September 20, 1894 (No. 1147).

Rumex maritimus, L. Sp. Pl. 335 (1753).

In saline soil; not frequent.

Clark's Ranch on Wind River, August 10, 1894 (No. 769); Sheridan, September 1895, J. F. Lewis.

Rumex occidentalis, Watson, Proc, Am. Acad. xii, 253 (1876).

Under this name are a number of specimens, some immature, and only the following typical:

Wallace Creek, July 29, 1894 (No. 561); Centennial Valley, August 16, 1895 (No. 1752).

Rumex paucifolius, Nutt. Ms. in Herb. Gray. *R. Geyeri,* (Meisn.) Trelease.

Abundant in subalpine parks; Union Pass, August 11, 1894 (No. 855); also observed in the Medicine Bow Mountains.

Rumex salicifolius, Weinm. Flora, iv, 28 (1813).

Frequent and somewhat variable in general appearance.

Whalen Canon, July 17 1894 (No. 561); Laramie, July 23, 1895 (No. 1449).

Rumex venosus, Pursh, Fl. Am. Sept. 733 (1814).

Frequent about sand dunes on the plains.

Laramie, June 3, 1894 (No. 156).

ELÆAGNACEÆ.

Eleagnus argentea, Pursh, Fl. Am. Sept. 114 (1814).

Very frequent on the Wind Rivers.

Fort Washakie, August 5, 1894 (No. 703).

Shepherdia argentea, Nutt. Gen. ii, 240 (1818). *Lepargyræa argentea,* (Nutt.) Greene. *Buffalo Berry.*

Common on the Platte; Bessemer, July 26, 1894 (No. 636).

Shepherdia Canadensis, Nutt. Gen. ii, 241 (1818). *Lepargyræa Canadensis,* (L.) Greene.

Common on moist and partially shaded slopes in the mountains.

Laramie Hills, May 12, 1894 (No. 25). Garfield Peak, July 29, 1894 (No. 687); Laramie Peak, August 5, 1895 (No. 1585).

LORANTHACEÆ.

Arceuthobium Americanum, Engelm. Pl. Lindl. ii, 214 (1850). *Razoumofskya Americana,* (Engelm.) Kuntze.

Infrequent; at Keystone, Medicine Bow Mountains, 1893, W. C. Knight.

SANTALACEÆ.

Comandra pallida, DC. Prodr. xiv, 636 (1857).

Frequent on dry slopes throughout the state.

Table Mountain, June 2, 1894 (No. 105); Gros Ventre River, August 18, 1894 (No. 1091).

EUPHORBIACEÆ.

Euphorbia dentata, Michx. Fl. Bor. Am. ii, 211 (1803).

Infrequent; observed but once; Hartville, July 15, 1894 (No. 549).

Euphorbia dictyosperma, Fisch. and Mey. Ind. Sem. Hort. Petrop. ii, 37 (1835).

On sand dunes near Mexican Mines, July 21, 1894 (No. 581).

Euphorbia Fendleri, T. & G. Pac. R. R. Rep. ii, 175 (1855).

Our *Euphorbias* seem to be confined to the warm sandy plains and canons of the eastern part of the state, particularly to the region of the Platte. This from Fairbanks, July 14, 1894 (No. 472).

Euphorbia glyptosperma, Engelm. Bot. Mex. Bound. Serv. 187 (1859).

Quite frequent; Wheatland, June 29, 1891; Blue Grass Hills, July 8, 1894 (No. 370).

Euphorbia hexagona, Nutt. Spreng. Syst. iii, 791 (1826).

In a sandy canon leading to the Platte, Fairbanks, July 13, 1894 (No. 436).

Euphorbia montana, Engelm. Bot. Mex. Bound. Surv. 192 (1859).

This is probably common throughout the state on stony, gravelly hillsides.

Inyan Kara Divide, August 29, 1892; Whalen Canon, July 18, 1894 (No. 529); Pole Creek, July 1, 1895 (No. 1400).

Euphorbia petaloidea, Engelm. l. c.

Not infrequent on sandy river bottoms.

Uva, July 10, 1894 (No. 399); Willow Creek, July 22, 1894 (No. 631).

Croton Texensis, Muell. Arg. in DC. Prodr. xv, part 2, 692 (1862).

On sandy river bottoms in the eastern part of the state.

Fairbanks, July 12, 1894 (No. 428); also at Fort Laramie.

URTICACEÆ.

Humulus Lupulus, L. Sp. Pl. 1028 (1753).

Not infrequent in copses on river bottoms and in ravines.

Whalen Canon, July 18, 1894 (No. 513). *Wild Hops.*

Urtica Breweri, Watson, Proc. Am. Acad. x, 348 (1875).

Abundant in Centennial Valley; not observed elsewhere; June 8, 1895 (No. 1273); August 25, 1895 (No 1862). *Nettle.*

Urtica gracilis, Ait. Hort. Kew. iii, 341 (1789).

Exceedingly abundant in copses on most streams.

Mexican Mines, July 20, 1894 (No. 590).

Parietaria Pennsylvanica, Muhl. Willd Sp. Pl. iv, 955 (1805).

Infrequent; Fairbanks, July 13, 1894 (No. 441).

CUPULIFERÆ.

Betula glandulosa, Mich. Fl. Bor. Am. ii, 180 (1803),

On the stony banks of subalpine streams.

Warm Spring Creek, August 10, 1894 (No. 799). *Mountain Birch.*

Betula occidentalis, Hook. Fl. Bor. Am. ii, 155 (1839).

Supposedly common on our streams, especially in the northeast, but only collected at Laramie Peak, August 8, 1895 (No. 1647). *Western Birch.*

Alnus incana virescens, Wats. Bot. Cal. ii, 81 (1880).

Frequent and abundant on our mountain streams, sometimes attaining the size of small trees.

Big Wind River, August 8, 1894 (No. 728); Cummins, July 29, 1895 (No. 1531); also in Centennial Valley. *Alder.*

Quercus undulata, Torr. Ann. Lyc. N. Y. ii, 248 (828).

This is reported abundant in the Black Hills, to which region it is probably confined; so far as known it is our only *Oak.*

Sundance, July 22, 1891, by B. C. Buffum.

SALICACEÆ.*

Salix arctica petræa, Anders.

Infrequent; not observed by the writer.

Collected by B. C. Buffum, Bald Mountain, August 15, 1892.

Salix alba x fragllis, Wienmer.

This Hybrid is among those in the City Park, October 1, 1894 (No. 1199).

Salix amygdaloides, Anders. Ofv. Handl. Vet. Akad. 1858, 114 (1858).

Typical specimens from Snake River, August 21, 1894 (No. 978).

My specimens from Big Popo Agie River, August 2, 1894 (No. 738)

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* The *Willows* were in large part determined by the late Mr. Bebb; those collected in 1895 only, by Mr. M. L. Fernald.

were designated by Mr. Bebb as "*forma sat singularis*," on account of the occurrence in the same individual of the following peculiarities: Leaves unusually short and broad, coarsely serrate and very conspicuously stipulate.

Salix candida, Fleugge, Willd. Sp. Pl. iv, 708 (1806).

Observed only in Centennial Valley, August 20, 1895 (No. 1755).

Salix chlorophylla, Anders. Monogr. 138 (1867).

Widely distributed; Union Pass, August 13, 1894 (No. 1029); Centennial Valley, August 19, 1895 (No. 1741).

Salix cordata, Muhl. Neue Schr. Ges. Nat. Fr. Berlin, iv, 236 (1803).

Collected but once; Laramie Peak, August 6, 1895 (No. 1598).

Salix curtiflora, (Anders) Bebb.

This very rare plant from two localities; not reported from this state before, I think, except by Mr. Tweedy.

Boulder Creek, August 26, 1894 (No. 1122); Centennial Valley, August 19, 1895 (No. 1754).

Salix desertorum, Rich. App. Frank. Journ. 371 (823).

On a hummocky heath in Centennial Valley, August 20, 1895 (No. 1759).

Salix desertorum elata, Anders.

Rare, alpine; Union Peak, August 13, 1894 (No. 1072); LaPlata Mines, August 22, 1895 (No. 1818).

Salix desertorum fruticulosa, Anders.

Infrequent in an open, heathlike park in Union Pass, August 11, 1894 (No. 913).

Salix flavescens, Nutt. Sylv. i, 65 (1842-53).

This beautiful species is the first to put out its blossoms of all our willows; the leaves follow very tardily.

Thus far noted only in the Laramie range; Pole Creek, May, 12, 1894 (No. 24) and at various other times; Laramie Peak, August 6, 1895 (No. 1586).

Salix lasiandra Fendleriana, (Anders.) Bebb.

Not infrequent; Popo Agie River, August 2, 1894 (No. 737); Pole Creek, June 30, 1895 (No. 1434).

Salix leucosericea, Nob. n. sp.

In communicating this name to me Mr. Bebb made the following comments upon the species: "It will shortly appear as above in a

government report. This is the Rocky Mountain or plateau member of a group which has for its eastern or Atlantic coast representatives, *S. sericea* and *S. petiolaris*, and for the Pacific coast *S. macrocarpa*."

Rare; observed only on Boulder Creek, August 26, 1894 (No. 1123).

Salix longifolia, Muhl. Neue Schr. Ges. Nat. Fr. Berlin, iv, 238 (1803).

On sand bars and creek banks everywhere, common and variable.

Laramie, June 16, 1894 (No. 245); near Lander, August 3, 1894 (No. 718); Cummins, July 26, 1895; (No. 1447).

Salix macrocarpa, Nutt.

I suppose this to be very rare in the state.

Centennial Valley, June, 9, 1895 (No. 1255).

Salix monticolo, Bebb.

Infrequent; Centennial Valley, August 18, 1895 (No. 1733).

Salix rostrata, Richards, Frank. Journ. App. 753 (1823).

Our commonest *Willow*.

Laramie, June 16, 1894 (No. 244); Centennial Valley, June 9, 1895 (No. 1303); also a low mountain form from Little Sandy, August 30, 1894 (No. 1130).

Salix sp.

Only foliage but clearly enough not any of the foregoing.

Populus acuminata, Rydberg, Bull. Torr. Club, xx, 50 (1893).

Our handsomest *Cottonwood* as well as the most rapid growing of our shade trees; planted extensively in Laramie.

Fine native specimens in Whalen Conon, July 17, 1894 (No. 560). *Rydberg's Cottonwood.*

Populus angustifolia, James, Long's Exp. i, 497 (1823).

This is very frequent on the principal streams of the state, in places forming considerable bordering groves, individual trees attaining great size.

Laramie, May 16, 1894 (No. 39). *Black Cottonwood.*

Populus balsamifera, L. Sp. Pl. 1034 (1753).

This is not frequent and I have not seen it except as single trees here and there.

Dubois, August 9, 1894 (No. 749); Cummins, July 29, 1894 (No. 1547).

Populus monilifera, Ait. Hort Kew. iii, 406 (1789).

This species is used to some extent for shade purposes. If native in the state I have not yet observed it.

Populus tremuloides, Michx. Fl. Bor. Am. ii, 243 (1803).

The *Quaking Asp* of the canons and hillsides, usually only a large shrub but in some places attaining considerable size as trees.

Laramie Hills, May, 12, 1894 (No. 23); noted in scores of other places.

HYDROCHARITACEÆ.

Elodea Canadensis, Michx. Fl. Bor. Am. i, 20 (1803). *Udora Canadensis,* Nutt.

In the ponds and springs on the Fish Hatchery grounds where it has probably been introduced. October 18, 1893.

ORCHIDACEÆ.

Calypso borealis, Salisb. Parad. Lond. t. 89 (1807). *C. bulbosa,* (L.) Oakes.

This beautiful little *Orchid* is as rare here as elsewhere. The following students each found one specimen on a partly wooded hillside at the head of Pole Creek. May 25, 1894 (No. 61): Lily Boyd, Tessie Welch and Ben Bartlett.

Listera convallarioides, (Sw.) Torr. Comp 320 (1826).

Very rare, only observed once; Centennial Valley, August 17, 1895 (No. 1694).

Spiranthes Romanzoffiana, Cham. Linnæa, iii, 32 (1828). *Gyrostachys Romanzoffiana,* (Cham.) MacM.

Abundant in a few localities; Centennial Valley, August 10, 1895 (No. 1663).

Habenaria gracilis, (?) Watson.

The following numbers, (420 and 1706) appear in our herbarium as *H. hyperborea,* but re-examination shows that they should probably be referred as above. Frequent in marshy places.

Chugwater Creek, July 7, 1894; Centennial Hills, August 17, 1895.

Habenaria hyperborea, R. Br. in Ait. Hort. Kew, Ed. 2, v, 203 (1813).

Specimens only from Big Wind River, August 8, 1894 (No. 725).

Habenaria obtusata, Richards. App. Frank. Journ. 750 (1823).
Very rare; Cummins, July 30, 1895 (No. 1544).

IRIDACEÆ.

Iris Missouriensis, Nutt. Journ. Acad. Phila. vii, 58 (1834).

Frequent on creek and river bottoms.

Laramie, June 18, 1894 (No. 260); Centennial Valley, June 9, 1895 (No. 1268).

Sisyrinchium Bermudiana, L. Sp. Pl. 954 (1753).

The specimens before me show the characters which were supposed to separate *S. angustifolius* and *S. mucronatum*, but the length of the spathes and the breadth of the wings are far from constant. It is well to unite them under this earlier name.

Laramie, June 1894 (No. 239); Wind River, at Dubois, August 10, 1894 (No. 767); in various other places.

LILIACEÆ.

Streptopus amplexifolius, DC. Fl. Fran. iii, 174 (1805).

In copses on mountain sides; Laramie Hills, June 28, 1891; Laramie Peak, Angust 6, 1895 (No. 1580).

Smilacina amplexicaulis, Nutt. Journ. Acad. Phil. vii, 58 (1834). *Vagnera amplexicaulis,* (Nutt.) Greene.

Very rare; thus far only observed on Casper Mountain, July 26, 1894 (No. 610).

Smilacina stellata, Desf. Ann. Mus. Paris, ix, 52 (1807). *Vagnera stellata,* (L.) Greene.

Frequent and abundant in the meadows bordering on all our streams.

Horse Creek, June 9, 1894 (No. 155); Platte River, July 24, 1894 (No. 632).

Yucca angustifolia, Pursh. Fl. Am. Sept. 227 (1814). *Y. glauca,* Nutt.

Frequent on sandy, gravelly hillsides.

Cummins, July 27, 1895 (No. 1460). *Spanish Bayonet.*

Leucocrinum montanum, Nutt, Gray, Ann. N. Y. Lyc. iv, 110 (1837).

Very common on the plains and foothills.

Laramie, May 15, 1894 (No. 1226); also from Table Mountain. *White Mountain Lily.*

Allium acuminatum, Hook. Fl. Bor. Am. ii, 184, t. 146 (1840).

On the Platte River, 1891, B. C. Buffum.

Allium brevistylum, Watson, Bot. King Exp. 350 (1871).

Frequent in rich loam soil in copses.

Big Horn Mountains, July 1892; Centennial Hills, August 1895 (No. 1704).

Allium cernuum, Roth. Roem. Arch. Bot. i, part 3, 40 (1798).

Very frequent; Inyan Kara Divide, August 31, 1892; Garfield Peak, July 29, 1894 (No. 661); Laramie Peak, August 7, 1895 (No. 1633).

Allium Nuttallii, Wats. Proc. Am. Acad. xiv, 227 (1879).

Not infrequent on gravelly river bottoms and hillsides.

Laramie, June 19, 1894 (No. 263); Pole Creek, June 30, 1895 (No. 1382).

Allium reticulatum, Don. Mem. Wern. Soc. vi, 36 (1826-31).

The earliest and commonest *Wild Onion* on the plains.

Laramie, June 15, 1894 (No. 222); Pole Creek, June 29, 1895 (No. 1353).

Allium Schœnoprasum, L. Sp. Pl. 301 (1753).

In wet places in the mountains.

Green River, August 15, 1894 (No. 907); La Plata Mines, August 23, 1895 (No. 1788).

Fritillaria atropurpurea, Nutt. Journ. Acad. Phila. vii. 54 (1834).

This is very rare; single specimens from the east slope of the Laramie Hills in June by B. C. Buffum, and on two occasions by Noah Wallis.

Erythronium grandiflorum, Pursh. Fl. i, 231 (1814).

Infrequent; alpine or at least subalpine.

Bald Mountain, August 16, 1892; La Plata Mines, August 22, 1895 (No. 1796).

Calochortus Gunnisoni, Wats. Bot. King's Exp. 348 (1871).

Among the sage brush in the valleys.

Sybille Creek, July 8, 1894 (No 319); Cummins, July 26, 1895 (No. 1451).

Calochortus Nuttallii, T. & G. Pac. R. R. Rep. ii, 124 (1855).

In similar locations and nearly resembling the preceding but for the anthers and glands.

Laramie Hills, June 18, 1891; also July 7, 1894 (No. 413).

Disporum trachycarpum, B. & H. Gen. Pl. iii, 832 (1883).

In copses on mountain rivulets.

Casper Mountain, July 26, 1894 (No. 609); Centennial Valley, June 9, 1895 (No. 1277).

Zygadenus elegans, Pursh. Fl. Am. Sept. 241 (1814).

Frequent; in wet, grassy places near streams.

Chugwater Creek, July 7, 1894 (No. 421); Cummins, July 27, 1895 (No. 1453).

Zygadenus Nuttallii, Wats. Proc. Am. Acad xiv, 279 (1879).

Abundant on sandy plains and in the foothills.

Laramie, June 16, 1894 (No. 254); observed in many localities.

COMMELINACEÆ.

Tradescantia Virginiana, L. Sp. Pl. 288 (1753).

Probably confined to the eastern part of the state.

Platte River, July 14, 1894 (No. 492).

JUNCACEÆ.*

Juncus Balticus, Willd. Berlin Mag. iii, 298 (1809).

Very frequent in wet ground near streams.

Laramie, June 16, 1894 (No. 243).

Juncus bufonius, L. Sp. Pl. 328 (1753).

Frequent about spring bogs and in occasionally flooded ditches.

Cold Springs, Fairbanks, July 13, 1894 (No. 437); Centennial Valley, August 25, 1895 (No. 1851).

Juncus longistylis, Torr. Bot. Mex. Bound. Surv. 223 (1859).

Infrequent; Centennial Valley, August 18, 1895 (No. 1716).

Juncus Mertensianus, Bong.

This is of frequent occurrence in the higher mountains.

La Plata Mines, August 22, 1895 (No. 1791).

Juncus nodosus, L. Sp. Pl. Ed. 2, 466 (1762).

Frequent; Laramie, September 1892; Little Sandy, July 1892; Wolf Creek, August 1892, by B. C. Buffum.

* For some further notes upon this and the order *Cyperaceæ*, see Bulletin No. 16 of this Station, by B. C. Buffum.

Juncus Parryi, Engelm. Trans. St. Louis Acad. ii, 447 (1866).
Alpine; Teton Mountains, August 21, 1894 (No. 981); La Plata Mines, August 24, 1895 (No. 1831).

Juncus subtriflorus, (Mey.) Coville, Contrib. Natl. Herb. iv, 208 (1893).
La Plata Mines, at about 11,000 ft., August 23, 1895 (No. 1812).

Juncus tenuis, Willd. Sp. Pl. ii, 214 (1799).
Lander, August 3, 1894 (No. 699).

Juncus tenuis congesta, Engelm. Trans. St. Louis Acad. ii, 446 (1866).
Infrequent; Laramie Peak, August 7, 1895 (No. 1631).

Juncus Torreyi, Coville.
Cold Springs, July 14, 1894 (No. 449); Teton Mountains, August 21, 1894 (No. 956).

Juncus xiphioides montanus, Engelm. Trans. St. Louis Acad. ii, 481 (1868).
Centennial Valley, August 18, 1895 (No. 1731).

Luzula spadicea parviflora, Meyer, Linnæa, xxii, 402 (1849). *Juncoides parviflorum,* (Ehrh.) Coville.
Not infrequent; Union Pass, August 11, 1894 (No. 846).

Luzula spadicea subcongesta, Watson, Bot. Cal. ii, 202.
In boggy places and partially dried up ponds.
Centennial Valley, August 16, 1895, and June 9, 1895 (No. 1261).

Luzula spicata, DC. Fl. Fr. iii, 161 (1805). *Juncoides spicatum,* (L.) Coville.
Alpine; Union Pass, August 11, 1894 (No. 847); noted also in the Medicine Bow Mountains

TYPHACEÆ.

Typha latifolia, L. Sp. Pl. 971 (1753).
Common in the margins of lakes and ponds.
Popo Agie River, August 1, 1894 (No. 734); abundant in the vicinity of Laramie.

ALISMACEÆ.

Alisma Plantago, L. Sp. Pl 342 (1753).
Rare; not observed by the writer.
Dutch Creek, Sheridan County, 1892, by B. C. Buffum.

Sagittaria arifolia, (?) Nutt. in Herb. *S. variabilis minor*, Pursh.

I have some hesitancy in referring it as above, but it is the best disposition I can make of it at present.

Collected in a marshy meadow stream near Lusk, July 21, 1894 (No. 577).

Sagittaria latifolia, Willd. Sp. Pl. iv, 409 (1806).

Probably rare; Wheatland, August 11, 1891, B. C. Buffum.

NAIADACEÆ.

Triglochin maritima, L. Sp. Pl. 339 (1753).

Common in alkali marshes.

Alkali Springs, July 30, 1894 (No. 745); also from Wind River, Laramie and other localities.

Triglochin palustris, L. Sp. Pl. 388 (1753).

In similar locations; Wind River, August 8, 1894 (No. 759).

Potamogeton pectinatus, L. Sp. Pl. 127 (1753).

In the Laramie River, August 9, 1895 (No. 1668.)

CYPERACEÆ.

Eleocharis compressa, Sull. Am. Journ. Sci. lxii, 50 (1842). *E. acuminata*, (Muhl.) Nees.

As yet only from the Big Horn Mountains, July 1892, B. C. Buffum.

Eleocharis olivacea, Torr. Ann. Lyc. N. Y. iii, 300 (1836).

Not infrequent in partially submerged ground.

Laramie, June 28, 1894 (No. 289); Cold Springs, July 14, 1894 (No. 455).

Eleocharis ovata, Roem. & Schult. Syst. ii, 152 (1817).

Specimens in the World's Fair collection secured in 1892.

Scirpus atrovirens, Muhl. Gram. 43 (1817).

Very common in marshy ground about springs and ponds.

Mexican Mines, July 20, 1894 (No. 591); Muddy Creek, August 25, 1894 (No. 1109).

Scirpus lacustris, L. Sp. Pl. 48 (1753).

Rare; noted only at Cold Springs, Fairbanks, July 14, 1894 (No. 454).

Scirpus pungens, Vahl. Enum ii, 255 (1806). *S. Americanus*, Pers.
Frequent; Cold Springs, Fairbanks, July 14, 1894 (No. 450).

Scirpus sylvaticus digynus, Bœckl. Linnæa, xxxvi, 727 (1870). *S. microcarpus*, Presl.
Infrequent; excellent specimens from Laramie Peak, August 6, 1895 (No. 1605).

Eriophorum polystachyon, L. Sp. Pl. 52 (1753).
Infrequent; Crazy Woman Creek, August 7, 1892, B. C. Buffum.

Carex alpina, Sw. Lilj. Sv. Fl. Ed. 2, 26, (1798).
Probably rather rare; head of Crazy Woman Creek, August 7, 1892.

Carex athrostachya, Olney, Proc. Am. Acad. vii, 393 (1868).
From Saratoga, August 1892.

Carex atrata, L. Sp. Pl. ii, 976 (1753).
Infrequent; alpine; La Plata Mines, August 23, 1895 (No. 1811).

Carex aurea, Nutt. Gen. ii, 205 (1818).
Rare; Wolf Creek, August 18, 1892, B. C. Buffum.

Carex canescens, L. Sp. Pl. 974 (1753).
Centennial Hills, August 18, 1895 (No. 1730).

Carex deflexa media, Bailey, Mem. Torr. Club. i, 42 (1889).
Big Sandy, July 1892, B. C. Buffum.

Carex Douglasii, Boott. Hook. Fl. Bor. Am. ii, 213, t. 214 (1840).
Secured in the Big Horn Mountains, August 8, 1892, B. C. Buffum.

Carex festiva. Dew. Am. Journ. Sci. xxix, 246 (1836).
Very abundant and apparently throughout the state.
Big Sandy, July, 1892; Laramie, June 28, 1894 (No. 288); also from Laramie Peak and Medicine Bow Mountains, in 1895 (Nos. 1615 and 1786).

Carex filifolia, Nutt. Gen. ii, 204 (1818).
Infrequent; Wheatland, August, 1891.

Carex geyeri, Boott. Trans. Linn. Soc. xx, 118 (1846).
Big Sandy, July, 1892, B. C. Buffum.

Carex Liddoni, Boott.
Big Horn Mountains, July 1892, B. C. Buffum.

Carex marcida, Boott. Hook. Fl. Bor. Am. ii, 212, t. 213 (1840).
In Carbon County, June 1892, B. C. Buffum.

Carex Nebraskensis, Dewey, Am. Journ. Sci. (II) xviii, 102 (1854).

This is a very common species in wet soil everywhere, even in soils with a considerable percentage of alkali; Laramie, June 19, 1894 (No. 274); Table Mountain, June 2, 1894 (No. 130).

Some specimens by B. C. Buffum are marked *C. Nebraskensis prævia*, Bailey, and it is not clear from the specimens nor from the literature at hand that they are different from the species.

Carex occidentalis, Bailey.

Apparently rare; Laramie Peak, August 6, 1895 (No. 1614).

Carex Pennsylvanica, Lam. Encycl. iii, 388 (1789).

Common on fertile hillsides among sage brush and other undershrubs.

Crook county August, 1892; Pole Creek, May 25, 1894 (No. 69).

Carex pratensis, Drejer, Rev. Crit. Car. Bor. 24 (1841).

Head of Crazy Woman Creek, August 8, 1892, B. C. Buffum.

Carex Raynoldsii, Dew. Am. Journ. Sci. xxxii, 39 (1837).

Infrequent; Bald Mountain, August 15, 1892, B. C. Buffum.

Carex siccata, Dew. Am. Journ. Sci. x, 278 (1826).

Abundant in native meadows on alkali soil.

Laramie, June 1, 1894 (No. 65).

Carex stenophylla, Wahl. Kongl. Acad. Handl. (II.) xxiv, 142 (1803).

Exceedingly abundant on the Laramie Plains in both dry and wet soil, the earliest *Sedge*, springing up as almost the first vegetation.

Laramie, May 16, 1894 (No. 19); at various other times.

Carex straminea brevior, Dew.

Rare; Lusk, July 21, 1894 (No. 586).

Carex straminea mirabilis, (Dew.) Tuck. Enum. Meth. 18 (1843).

Specimens communicated by J. F. Lewis, of the Sheridan Experiment Farm, September 1, 1895.

Carex tenella, Schk. Riedgr. 23, Fig. 104 (1801).

Some specimens from Wolf Creek, August 18, 1892, B. C. Buffum.

Carex Tolmiei, Boott.

Table Mountain, June 2, 1894 (No. 100); also from the Big Horn Mountains, August 6, 1892, B. C. Buffum.

Carex utriculata, Boott. Hook. Fl. Bor. Am. ii, 221 (1840).

Infrequent; Muddy Creek, August 25, 1894 (No. 1108).

Carex utriculata minor, Boott. l. c.

This seems to be of more frequent occurrence than the species.

Saratoga, 1891, by J. D. Parker; Laramie River, in Laramie county, September, 1892, B. C. Buffum.

Carex sp.

Somewhat resembling *C. Nebraskensis*, but with culms several times as long as the leaves; spikes few, the terminal one much the longer.

Cold Springs, at Fairbanks, July 13, 1894 (No. 447).

GRAMINEÆ.*

Andropogon provincialis, Lam. Encycl. i, 376 (1783).

Common in the eastern part of the state.

Wheatland, July, 1892, B. C. Buffum.

Andropogon scoparius, Michx. Fl. Bor. Am. i, 57 (1803).

Frequent; Hartville, July 18, 1894 (No. 531); also by B. C. Buffum, 1892.

Panicum capillare, L. Sp. Pl. 58 (1753).

Common in all parts of the state.

Crook county, 1892; Fairbanks, July 15, 1894 (No. 553); Sheridan Experiment Farm, September 1, 1894. *Old Witch Grass.*

Panicum Crus-galli, L. Sp. Pl. 56 (1753).

Presumably introduced but often found where such introduction would not be suspected.

Cummins, July 29, 1895 (No. 1500); Sheridan, September 1, 1895, J. F. Lewis.

Panicum sanguinale, L. Sp. Pl. 57 (1753).

Very generally introduced. Lander, June 1892; noted in other localities.

Panicum scoparium, Lam. Encycl. iv, 744 (1797).

Infrequent; Whalen Canon, July 18, 1894 (No. 516).

Panicum virgatum, L. Sp Pl. 59 (1753).

Fort Laramie, September, 1892, B. C. Buffum; Sheridan, September, 1895.

* The Grasses were determined in part by each of the following: Dr. W. J. Beal, Dr. F. Lamson-Scribner and Prof. B. C. Buffum. For further notes upon them see "Grasses and Forage Plants," Bulletin No. 16 of this Station, by B. C. Buffum.

Setaria viridis, Beauv. Agrost. 51 (1812). *Chamæraphis viridis,* (L.) Porter.

A troublesome weed in cultivated ground.

Wheatland, August 11, 1891. *Meadow Fox-tail.*

Cenchrus tribuloides, L. Sp. Pl. 1050 (1753).

Common on the sandy plains of the Platte.

Fort Laramie, September 5, 1892, B. C. Buffum. *Sand Bur.*

Phalaris arundinacea, L. Sp Pl. i, 55 (1753).

Collected in 1891; no other data.

Hierochloa borealis, R. & S.

Not frequent; Bald Mountain, August 15, 1892.

Aristida purpurea, Nutt. Trans. Am. Phil. Soc. (II.) v, 145 (1833-37). A. *fasciculata,* Torr.

Whether specimens are typical or belong to one of the varieties of this species I am unable to say. This form is common in the state.

Wheatlaud, July, 1891; Whalen Canon, July 19, 1894 (No. 539).

Stipa comata, Trin. and Rupr. Mem. Acad. St. Petersb. (VI) v, 75 (1842).

Frequent on the plains and in dry valleys; when mature an annoying and worthless grass.

Laramie, June 17, 1891; June 28, 1894 (No. 284).

Stipa spartea, Trin. Mem. Acad. St. Petersb. ser. 6, i, 82 (1829).

On the plains of the eastern part of the state, 1891.

Stipa viridula, Trin. Mem. Acad. St. Petersb. ser. 6, v, 39 (1836).

Big Sandy, Fremont county, July, 1892.

Oryzopsis exigua, Thurb. Bot. Wilkes Exp. 481.

Hitherto, it seems, reported only from Oregon and Washington.

Big Sandy, in the Wind River Mountains, July 22, 1892, B. C. Buffum.

Oryzopsis menbranacea, Vasey, Grasses S. W. part 2, t. 10 (1891).

Very abundant on the plains and in the foothills.

University Campus, September 16, 1894 (No. 1137); noted in many other places. *Mountain Rice.*

Muhlenbergia comata, Benth. Vasey's Cat. Grasses U. S. 39 (1885).

Spring Creek, Big Horn Mountains, August 5, 1892.

Muhlenbergia dumosa, Scrib. in Vasey, Contr. Nat. Herb. iii, 71.
Frequent in the eastern part of the state.
Wheatland, August 16, 1891.

Muhlenbergia glomerata, Trin. Unifl. 191 (1824). *M. racemosa,* (Michx.) B. S. P.
From Wolf Creek, Rawhide Creek and Fort Laramie, 1892, B. C. Buffum.

Muhlenbergia gracilis breviaristata, Vasey, Rothr. in Wheeler's Rep. vi, 284.
Plumbago Canon, July 1891.

Phleum alpinum, L. Sp Pl. 59 (1753).
Common in the alpine region of all our mountain ranges.
Union Pass, August 10, 1894 (No. 863); La Plata, August 22, 1895 (No. 1781). *Wild Timothy.*

Alopecurus geniculatus fulvus, (J. E. Smith) Scrib. List. Pterid & Sperm. 38 (1894).
Frequent; Whalen Canon, July 19, 1894 (No. 544); Centennial Valley, August 18, 1895 (No. 1721).

Sporobolus airoides, Torr. Pac. R. R. Rep. vii, part 3, 21 (1856).
Fort Washakie Hot Springs, July, 1892, B. C. Buffum.

Sporobolus asperifolius, Thurb. in Wats. Bot. Cal. ii, 269 (1880).
Probably infrequent; Cheyenne, August, 1891.

Sporobolus cryptandrus, Gray, Man. 576 (1848).
Rather frequent, on dry ridges.
Wheatland, September 8, 1892; Fairbanks, July 13, 1894 (No. 435).

Sporobolus cuspidatus, Scribn. Bull. Torr. Club, x, 63 (1882). *S. brevifolius,* (Nutt.) Scribn.
Fremont county, July, 1892.

Sporobolus heterolepis, Gray, Man. 576 (1848).
Crook county, August, 1892.

Agrostis alba, L. Sp. Pl. 63 (1753).
Common; Crook county, 1892; Laramie, October 6, 1894 (No. 1172).

Agrostis asperifolia, Trin. Mem. Acad. St. Petersb. Sci. Nat. ser. 6, 318 (1845).
Infrequent; Centennial Valley, August 18, 1895 (No. 1719).

Agrostis exarata, Trin. Unifl. 207 (1824).

Head of Rawhide Creek, August 1892.

Agrostis humilis, Vasey, Bull. Torr. Club, x, 21.

Alpine, in wet soil; La Platta Mines, August 23, 1895 (No. 1814).

Agrostis scabra, Willd. Sp. Pl. i, 370 (1798).

Frequent; Big Sandy, July, 1892; Albany county, September, 1891.

Calamagrostis Canadensis, Beauv. Agrost. 15 (1812).

Wind River Mountains, July, 1892.

Calamagrostis confinis, Nutt. Gen. i, 47 (1818).

Common; Centennial Valley, September 7, 1891; Laramie, September 30, 1894 (No. 1179).

Calamagrostis longifolia, Hook. Fl. Bor. Am. 241 (1840). *Calamovilfa longifolia,* (Hook.) Hack.

Frequent; Lander, July, 1892; Whalen Canon, July 9, 1894 (No. 536).

Calamagrostis Montanensis, Scribn.

Sheridan county, August, 1892.

Calamagrotis neglecta, (Ehrh.) Gærtn. Fl. Wett. i, 94 (1799).

Frequent; Big Horn Mountains, August, 1892; Orin Junction, August 14, 1891.

Calamagrostis pallida, Vasey & Scribn.

Eagle Rock Canon, September 22, 1891; also from Carbon county.

Calamagrostis purpurascens, R. Br., in Rich. Bot. App. Frank. Voy. 3.

Infrequent; Laramie Peak, August 7, 1895 (No. 1627).

Deschampsia cæspitosa, Beauv. Agrost. 160, t. 18, f. 3 (1812).

Common in the mountains; Big Sandy, July, 1892; La Plata Mines, August 23, 1895 (No. 1815).

Deschampsia cæspitosa arctica, Vasey.

Rare; Laramie Hills, June 12, 1894 (No. 238).

Trisetum subspicatum, Beauv. Agrost. 180 (1812).

Very abundant in the mountains; Big Sandy, July, 1892; La Plata Mines, August 22, 1895 (No. 1783).

Trisetum subspicatum molle, Gray, Man. Ed. 2, 572 (1856).

La Plata, Medicine Bow Mountains, August 23, 1895 (No. 1807).

Trisetum Wolfii, Vasey.

Fort Laramie, September 6, 1892, B. C. Buffum.

Danthonia Californica, Boland. Proc. Cal. Acad. ii, 182 (1862-63).
Sheridan county, August, 1892.

Danthonia intermedia, Vasey.
Big Sandy, Fremont county, July, 1892.

Danthonia unispicata, Munro. *D. Californica unispicata,* Thurb. Bot. Cal. ii, 294 (1880).
Apparently rare; Laramie Peak, August 7, 1895 (No. 1630).

Spartina cynosuroides, Willd Enum. Pl. 80 (1809).
Common and widely distributed; Inyan Kara Divide, August 30, 1892; C. Y. Ranch, on Big Muddy, July 23, 1894 (No. 599).

Schedonnardus Texanus, Steud. Syn. Pl. Gram. 146 (1855). *S. paniculatus,* (Nutt.) Scribn.
Abundant on the plains of the eastern part of the state.
Orin Junction, August, 1891.

Bouteloua oligostachya,Torr. Gray, Man. Ed. 2, 553 (1856).
A very common grass on the plains.
Wheatland, June 11, 1891; noted in many localities.

Bouteloua racemosa, Lag. Var. Clenc. y Litter. 2: Part 4, 141 (1805). *B. curtipendula,* (Michx.) Torr.
This, like the preceding, is very abundant in many localities.
Inyan Kara Divide, August 30, 1892; Hartville, July 18, 1894 (No. 530).

Beckmannia erucæformis, Host. Gram. Austr. iii, 5 (1805).
In swampy ground along our streams.
Big Sandy, July, 1892: Union Pass, August 11, 1894 (No. 828); Cummins, July 30, 1895 (No. 1533).

Buchloe dactyloides, Engelm. Trans. St. Louis Acad. i, 432 (1859). *Bulbilis dactyloides,* (Nutt.) Raf.
This is still found in considerable abundance on some of our plains, but it seems that it is gradually being killed out and replaced by other grasses.
Wheatland, September, 1892, and noted in many parts of the state. *Buffalo Grass.*

Munroa squarrosa, Torr. Pac. R. R. Rep. iv, 158 (1856).
Noted only in the eastern part of the state,
Wheatland, August, 1891; Blue Grass Creek, July 8, 1894 (No. 372).

Phragmites communis, Trin. Fund. Agrost. 134 (1820). *P. Phragmites*, (L.) Karst.

Not noted by the writer, but fine specimens by B. C. Buffum, from Little Muddy Creek, Casper, August 12, 1891. *Reed Grass.*

Eragrostis major, Host. Gram. Austr. 4: 14, t. 24 (1809).

Sparingly introduced about Wheatland and probably in other localities; September, 1892, B. C. Buffum.

Eatonia obtusata, Gray, Man. Ed. 2, 558 (1856).

Frequent; Crook county, August, 1892; Fairbanks, July 14, 1894 (No. 459).

Koeleria cristata, Pers. Syn. i, 97 (1812).

Common everywhere; Johnson county, August, 1892; Laramie, June 28, 1894 (No. 283), and noted in numerous localities.

Catabrosa aquatica, Beauv. Agrost. 157, t. 19, f. 8 (1812).

Throughout the state; Crook Creek, June 28, 1891; Cottonwood Canon, August 4, 1895 (No. 1567).

Melica bulbosa, Geyer.

Infrequent; Bald Mountain, August 16, 1892.

Distichlis maritima, Raf. Journ. Phys. lxxxix, 104 (1818). *D. spicata*, (L.) Greene.

Frequent on wet alkali flats.

Big Wind River, August 1, 1892; Alkali Springs, July 31, 1894 (No. 659).

Poa alpina, L. Sp. Pl. 67 (1753).

Rare, as well as rarely beautiful; Bald Mountain, August 15, 1892.

Poa andina, Nutt. Wats. Bot King Exp. 388 (1871). *P. arida*, Vasey.

Common on dry slopes; Middle Pass, June 21, 1892; Laramie, June 5, 1895 (No. 1245).

Poa Californica, Vasey, Cat. Grasses, U. S. 81 (1885). *P. Fendleriana.* (Steud.) Vasey.

Infrequent; Big Sandy, July, 1892.

Poa cæsia strictior, Gray.

Laramie Hills, June, 1892, B C. Buffum.

Poa cuspidata, Vasey.

Carbon county, June, 1892; La Plata Mines, August 22, 1895 (No. 1782).

Poa lævis, Vasey.

Carbon county, June, 1892.

Poa nemoralis, L. Sp. Pl. 69 (1753).

This is of frequent occurrence; Big Sandy, July, 1892; Laramie, June 19, 1894 (No. 272).

Poa Nevadensis, Vasey, Bull. Torr. Club, x, 66 (1883).

I am unable to say whether this is frequent or not. I notice it mentioned by others as a valuable forage grass. Specimens at hand only from Big Sandy, July, 1892.

Poa occidentalis, Vasey.

This fine species is common on the streams near Laramie; Fish Hatchery, July, 1891; Laramie River, June 22, 1895 (No. 1317).

Poa pratensis, L. Sp. Pl. 67 (1753).

Collected in 1892 for the World's Fair exhibit; common. *Blue Grass.*

Poa reflexa, Vasey & Scribn.

An alpine or subalpine species.

Bald Mountain, August 16, 1892; La Plata Mines, August 24, 1895 (No. 1837).

Poa rupestris, Vasey.

Rare; noted but once at 11,000 ft.; La Plata Mines, August 23, 1895 (No. 1813).

Poa serotina, Ehrh. Beitr. vi, 83 (1793). *Poa flava,* L.

Cheyenne, August 11, 1891. *False Red Top.*

Poa tenuifolia, Nutt. Buckley, Proc. Acad. Phila. 1862, 96 (1862).

Very common throughout the state.

Big Sandy, July, 1892; Laramie Hills, May 23, 1894 (No. 49). *Bunch Grass.*

Poa Vaseyana, Scribn.

This fine species was found in abundance by Prof. Buffum, on the Big Sandy, July 1892. He sent it for determination to Dr. Beal, who pronounced it probably new. Whether specimens were later sent to the Department of Agriculture or the same had been collected by Dr. Vasey I am unable to say, but subsequently it received the above name.

Poa sp.

Of this, Dr. F. Lamson-Scribner writes: "I am not prepared to name it. It has some characters in common with *Poa occidentalis,* Vasey, but it is apparently distinct from that."

Glyceria arundinacea, Kunth.

On Spring Creek, Big Horn Mountains, August 5, 1892.

Glyceria grandis, Wats, Gray, Man. Ed. 6, 667 (1890). *Panicularia aquatica,* (L.) Kuntze.

Common in partially submerged meadow lands.

Big Horn Valley, July, 1892; Cummins, July 30, 1895 (No. 1534).

Glyceria pauciflora, Presl. Rel. Hænk. i, 257 (1830). *Panicularia pauciflora,* (Presl.) Kuntze.

Infrequent; Centennial Valley, August 18, 1895 (No. 1720).

Festuca confinis, Vasey.

Big Horn Mountains, August, 1892; Carbon county, June 11, 1892; Pole Creek June 2, 1894 (No. 161); Wallace Creek, July 29, 1894 (No. 667).

Festuca gracillima, Hook.

Big Sandy, Wind River Mountains, July, 1892.

Festuca ovina, L. Sp. Pl. 73 (1753).

From Laramie county, August, 1891.

Festuca ovina brevifolia, Chlor. Melv. 289 (1823).

Big Sandy, July, 1892.

Festuca rubra, L. Sp. Pl. 74 (1753).

Wind River Mountains, July, 1892.

Festuca tenella, Willd. Enum i, 113 (1809). *F. octoflora,* Walt. Fl. Car. 81.

Wheatland, 1892, by M. R. Johnson.

Bromus breviaristatus, (Hook.) Buckl. Proc. Acad. Phila. 1862, 98 (1862).

Wolf Creek, July, 1892.

Bromus ciliatus, L. Sp. Pl. 76 (1753).

Inyan Kara Divide, August 30, 1892.

Bromus Hookerianus, Thurb.

Centennial Valley, September 7, 1891.

Bromus Kalmii occidentalis, Vasey.

Union Pass, August 11, 1894 (No. 821); Sand Creek, Fremont County, August 27, 1894 (No. 1105).

Bromus Pumpellianus, Scribn.

Big Wind River, July 1892.

Agropyrum caninum, R. & S. Syst. ii, 756 (1817).

Specimens in the World's Fair collection, 1892.

Agropyrum divergens, Nees. Steud. Syn. Gram. 347 (1855).

Frequent in the northern part of the state.

Lander, July 1892; Union Pass, August 11, 1894 (No. 820).

Agropyrum glaucum, R. & S. Syst. Veg. ii, 752 (1817). *A. repens glaucum*, (Desf.) Scribn.

One of the most valuable of the native hay grasses, producing heavy crops under judicious irrigation. It is essentially an upland grass and over-irrigation will soon destroy it.

Lander, July 1892; Laramie and other places at various times.

Agropyrum unilaterale, Cassidy, Bull. Col. Exp. Station xii, 63 (1890) *A. caninum unilaterale* (Cassidy) Vasey.

Sheridan, August 18, 1892.

Agropyrum violaceum, Vasey, Grasses U. S. Spec. Rep. No. 63, 45.

A valuable forage plant; Big Sandy, July 1892.

Hordeum jubatum, L. Sp. Pl. 85 (1753).

The worst weed in the state; a positive pest in the hay fields. Its extermination should receive every encouragement.

Hartville, July 16, 1894 (No. 558), and noted in numerous places.

Hordeum nodosum, L. Sp. Pl. Ed. 2, 126 (1762).

Infrequent; Big Horn Mountains, August 4, 1892.

Hordeum pusillum, Nutt. Gen. i, 87 (1818).

Infrequent; Platte River, Fairbanks, July 11, 1894 (No. 426).

Elymus Canadensis, L. Sp. Pl. 83 (1753).

Frequent but hardly common; Whalen Canon, July 18, 1894 (No. 552), and by B. C. Buffum in 1892.

Elymus condensatus, Presl. Rel. Hænk. i, 265 (1830).

Common along streams in the eastern part of the state

Wheatland, 1892.

Elymus sitanion, Schult. Mant. ii, 426 (1824). *E. elymoides*, (Raf.) Swezey.

On mountain slopes at high altitudes.

Union Peak, August 13, 1894 (No. 1021); Laramie Peak, August 6, 1895 (No. 1602).

Elymus Virginicus, L. Sp. Pl. 84 (1753).

Not common; Prairie Dog, August 8, 1892.

CONIFERÆ.

Pinus flexilis, James, Long Exp. ii, 35 (1823).

This is common in our mountain ranges.

Laramie Hills, May 12, 1894 (No. 18); Cummins, July 29, 1895 (No. 1501). *Rocky Mountain White Pine.*

Pinus Murrayana, Balfour, Jeffr. Rep. Oreg. Exp. (1853).

Noted in the foothills in the Laramie and Medicine Bow ranges, where it is of frequent occurrence along streams.

Our specimens from Pole Creek, May 12, 1894 (No. 12); May 18, 1895 (No. 1213). *Lodge Pole Pine.*

Pinus ponderosa scopulorum, Engelm. Wats. Bot. Cal. ii, 126 (1880).

This forms a somewhat scattering growth on the higher more exposed ridges in the Laramie range, and less conspicuously so in the other ranges visited.

Laramie Hills, May 12, 1894 (No. 17). *Rocky Mountain Yellow Pine.*

Picea Engelmanni, Engelm.

This forms a considerable proportion of the forest growth in the Medicine Bow and probably in the other ranges of our state. Attaining its most luxuriant growth at about 9,000 ft., it is the sole survivor of the trees at timber line and there becomes reduced and spreading-prostrate. Said to be the most valuable of our trees for lumber.

Union Pass, August 13, 1894 (No. 1014); La Plata Mines, August 24, 1895 (No. 1841). *Engelmann's Spruce.*

Picea pungens, Engelm.

This is much less common and usually occurs along streams in the wooded foothills. It is considered the most beautiful of our Spruces and is well worthy of the high esteem in which it is held as an ornamental tree.

Laramie Hills, May 12, 1894 (No. 16); Cummins, July 30, 1895 (No. 1549). *Blue Spruce. Balsam.*

Pseudotsuga Douglasii, Carr.

The largest of our forest trees, attaining a remarkable size in the lower altitudes of our mountain ranges.

Laramie Hills, May 12, 1894 (No. 14); April 1895 (No. 1208); *Douglas Spruce.*

Juniperus communis, L Sp. Pl. 1040 (1753).

Very rare; Cummins, July 28, 1895 (No. 1481).

Juniperus communis alpina, Gaud. Fl. Helv. vi, 301 (1830). *J. nana,* Willd.

This is abundant on hillsides at all altitudes.

Laramie Hills, May 4, 1894 (No. 11); Little Sandy, August 30,

1894 (No. 1128). *Prickly Juniper.*

Juniperus Sabina procumbens, Pursh, Fl. Am. Sept. 647 (1814). *J. Sabina,* L.

Rare; observed only on the alpine summits of the Medicine Bow Mountains, La Plata, August 24, 1895 (No. 1834).

Juniperus Virginiana, L. Sp. Pl. 1039 (1753).

This is frequent, varying within our range from a prostrate, scraggly shrub to a large tree. Incorrectly called *Red Cedar.*

Laramie Hills, April 4, 1894 (No. 1). *Virginia Juniper.*

EQUISETACEÆ.

Equisetum arvense, L. Sp. Pl. 1061 (1753).

Frequent on water courses.

Pole Creek, May 25, 1894 (No. 77); July 2, 1895 (No 1411).

Equisetum arvense alpestre, Wahl.

Not common; occurring usually on abrupt wet creek banks.

Big Wind River, August 5, 1894 (No. 706).

Equisetum hiemale, L. Sp. Pl. 1062 (1753).

Common on sandy river bottoms.

Laramie River, June 19, 1894 (No. 275); Laramie Peak, August 8, 1895 (No. 1640). *Scouring Rush.*

Equisetum lævigatum, A. Br. Engelm. Am. Journ Sci. xlvi, 87 (1844).

Infrequent; C. Y. Ranch on the Big Muddy, July 23, 1894 (No. 604).

Equisetum variegatum, Schleich. Cat. Pl. Helv. 27 (1807).

Fish Hatchery at Laramie, July 1891; Pole Creek, June 28, 1895 (No. 1355).

FILICES.

Asplenium Filix-fœmina, (L.) Bernh. Schrad. Neues. Journ. Bot. i, part 2, 26 (1806).

Infrequent; Jackson's Hole, August 21, 1894 (No. 940).

Cheilanthes lanuginosa, Nutt. Hook. Sp. Fil. ii, 99 (1858). *C. gracilis,* Mett.

In dry, rocky, cliffs; Laramie, 1891; Platte Canon, July 13, 1894 (No. 442).

Chryptogramma acrostichoides, R. Br. App. Frank. Journ. 767 (1823).

Teton Mountains, August 21, 1894 (No. 950).

Cystopteris fragilis, (L.) Bernh. Schrad. Neues. Journ. Bot. i, part 2, 27 (1806).

Common; Pole Creek, June 2, 1894 (No. 97); Mexican Mines, July 20, 1894 (No. 587).

Notholæna sinuata, Kaulf.

A specimen by B. C. Buffum, July 8, 1892; no other data.

Pteris aquilina, L. Sp. Pl. 1075 (1753).

Teton Mountains, August 21, 1894; Laramie Peak, August 6, 1895 (No. 1601).

Woodsia Oregana, Eaton, Can. Nat. ii, 90 (1865).

Centennial Hills, August 16, 1895 (No. 1682).

Woodsia scopulina, Eaton, l. c.

Much more frequent than the preceding; in crevices and on rocky ledges throughout our range.

Teton Mountains, August 21, 1894 (No. 951); Laramie Peak, August 6, 1895 (No. 1594).

SELAGINELLACEÆ.

Selaginella rupestris, Spring, in Mart. Fl. Bras. i. part 2, 118 (1840).

On a dry, naked ridge near table Mountain, June 28, 1895 (No. 1345).

MUSCI.*

Ceratodon purpureus, Brid. Bryol. Univ. i, 480 (1826).

Head of Pole Creek, May 18, 1895 (No. 1211 in part).

Desmatodon latifolius glacialis, Schimp. Syn. 157.

Nearly alpine; La Plata Mines, August 24, 1895 (No. 1835).

Desmatodon Porteri, James, Aust. Musc. Appal. n. 123.

Cummins, July 30, 1895 (No. 1538 in part).

Barbula mucronifolia, Bruch. & Schimp. Mon. xxxviii, t. 23 (1842).

Cummins July 30, 1895 (No. 1538 in part).

Philonotis fontana, Brid. Bryol. Univ. ii, 18 (1827).

Centennial Valley, August 18, 1895 (No. 1756); LaPlata Mines, August 22, 1895 (No. 1800).

Aulacomnium papillosum, Lesq. & James, Man. Moss. N. A. 253.

Centennial Valley, August 19, 1895 (No. 1746).

* The Musci were determined and arranged by Prof. J. M. Holzinger.

Leptobryum pyriforme, Schimp. Syn. Musc. Eur. 390 (1876).
Centennial Valley, August 18, 1895 (No. 1717).

Webera albicans, Schimp. Coroll. 67.
Pole Creek, near Table Mountain, July 1, 1895 (No. 1285).

Webera elongata, Schwægr. Spec. Musc. 48.
Centennial Valley; August 18, 1895 (No. 1723 in part).

Webera sp.
Specimens sterile, but different from the preceding.
Centennial Valley, August 19, 1895 (No. 1745).

Bryum cæspiticium, L. Sp. Pl. ii, 1121 (1753).
Head of Pole Creek, May 18, 1895 (No. 1211 in part).

Bryum cirrhatum, Hoppe & Hornsch. Fl. 90 (1819). var. ?
Cummins, July 30, 1895 (No. 1538 in part).

Bryum intermedium, Brid. Musc. Recent Suppl. iv, 120.
Centennial Valley, June 8, 1895 (No. 1263).

Bryum pseudotriquetrum, Schwægr. Suppl. i, 2, 110.
Centennial Valley, June 8, 1895 (No. 1259).

Mnium subglobosum, Bruch. & Schimp. Bryol. Eur. t, 388.
Centennial Valley, August 19, 1895 (No. 1744).

Timmia Austriaca, Hedw. Sp. Musc. 176, t. 42 (1801).
Laramie Peak, August 8, 1895 (No. 1645).

Polytrichum juniperinum alpinum, Schimp. Syn. 447.
La Plata Mines, August 24, 1895 (No. 1830).

Polytrichum piliferum, Schreb. Spicil. Fl. Lips. 74.
La Plata mines, August 21, 1895 (No. 1769).

Climacium Americanum, Brid. Musc. Recent Suppl. ii, 45.
Centennial Valley, August 19, 1895 (No. 1724).

Pseudoleskea oliogoclada, Vindb.
Centennial Valley, August 18, 1895 (No. 1734).

Thuidium Blandovii, Bruch. & Schimp. Bryol. Eur. t. 486.
Centennial Valley, August 19, 1895 (No. 1746 in part).

Brachythecium acutum, Sulliv. Icon Musc. Suppl. 99, t. 75.
Centennial Valley, August 17, 1895 (No. 1698).

Brachythecium rivulare, Bruch & Schimp. Bryol. Eur. t. 543.
Laramie Peak, August 7, 1895 (No. 1622).

Hypnum commutatum, Hedw. Musc. Frond. iv, 68, t. 24.
Gros Ventre River, August 16, 1894 (No. 1088).

Hypnum plicatile, Lesq. & James. Man. Moss. N. A. 394.
Cummins, July 29, 1895 (No. 1507).

MARCHANTIACEÆ.

Marchantia polymorpha, L.
Frequent on wet banks; Green River, August 25, 1894 (No. 1005). Centennial Valley, August 18, 1895 (No. 1748).

ALGÆ.

The Algæ have received no attention so far as specific determination is concerned. In the collection of material for class use in the laboratory it has been found that quite a large number of genera are represented, some of them by a number of species. Among these *Spirogyra*, *Zygnema* and *Vaucheria* may be named. *Diatomaceæ* are everywhere but the *Desmidiaceæ* are not so well represented.

Among the larger forms the two following are conspicuous in the ponds at the city springs:

Chara fœtida, A. Br.
It forms a dense growth over the bottom of the ponds, in places reaching a foot or more in height.

Batrachospermum gelatinosum, (L.) A. F. Woods, Rep. Bot. Surv. Neb. iii, 6 (1894).
Adherent to stones in running water.

Chara sp.
A rather unusual *Chara* was collected in a pool in the mouth of an extinct geyser pan on Warm Spring Creek. It is in the hands of Mr. J. W. Blankinship for determination; August 9, 1894 (No. 796).

FUNGI.

The following Fungi have been determined by Mr. J. B. Ellis. They include only incidental "pickups" in the field. Those of economic importance that we have had to deal with on the Experiment Farm are not included.

Æcidium abundans, Pk.
Cummins, July 29, 1895 (No. 1498). On *Symphoricarpos eriophilus.*

Æcidium monoicum, Pk.

Laramie Hills, May 23, 1894 (No. 50). On *Sisymbrium linifolium.*

Æcidium Œnothera, Mont.

Pole Creek, June 2, 1894 (No. 133). On *Œnothera brachycarpa.*

Uromyces Junci, (Schw.) Tul.

Laramie, December, 1895 (No. 1207). On *Juncus sp.*

Erysiphe cichoracearum, DC.

Cummins, July 29, 1895 (No. 1516). On *Hydrophyllum occidentale.*

Melampsora farinosa, (Pers) Schrœt.

Cummins, July 29, 1895 (No. 1520); Centennial Valley, August 25, 1895 (No. 1864). Frequent on various *Willows.*

Phragmidium subcorticum, Schrank.

Cummins July 29, 1895 (No. 1499). On *Rosa blanda* (?).

Ramularia sidalcea, E. & E.

Cummins, July 29, 1895 (No. 1468). On *Sidalcea candida.* Mr. Ellis writes of this as follows; "I have seen it but once before. It was from British Columbia, sent by Dr. Macoun."

LICHENES.

The following are a few of our commoner *Lichens*:

Cladonia pyxidata, Fr. Centennial Valley, August 18, 1895 (No. 1749).

Evernia vulpina, Ack. Centennial Hills, August 17, 1895 (No. 1699).

Parmelia conspersa, Ehrh. Pole Creek, July 1, 1895 (No. 1387).

Parmelia molliuscula, Ack. Laramie, July 23, 1895 (No. 1429).

Peltigera aphthosa, Hoffm. Laramie Peak, August 8, 1895 (No. 1644).

Peltigera canina, Hoffm. Cummins, July 29, 1895 (No. 1508).

Rinodina turfacea, Kœrb. Centennial Hills, August 17, 1895 (No. 1713).

Appendix to List of Species.

***Arabis Drummondii,** Gray, Proc. Am. Acad. vi, 187.

On fertile hillsides in the mountains; not frequent.

Union Pass, August 10, 1894 (No. 875); Centennial Hills, June 7, 1895 (No. 1248).

Arabis hirsuta, (L.) Scop. Fl. Carn. Ed. 2, ii, 30 (1772),

In sandy valleys, sometimes among the sage brush; frequent.

Laramie Hills, June 7, 1894 (No. 181); Union Pass, August 13, 1894 (No. 1074); Pole Creek, July 1, 1895 (No. 1394).

Arabis Holbœllii, Hornem. Fl. Dan. t. 1879 (1827).

On a dry, stony sandbar of the Laramie River, Cummins, July 30, 1895 (No. 1551).

Arabis Holbœllii Fendleri, Wats. Syn. Fl. i, 164 (1895).

Noted only in the sand beds of the stony foothills of the Laramie range; May 16, 1894 (No. 32).

Arabis Lemmoni, Wats. Proc. Am. Acad. xxii, 467 (1887).

Among the sage brush on the plains; infrequent.

, Laramie, May, 23, 1894 (No. 56).

Arabis Lyalli, Watson, Proc. Am. Acad. xi, 122.

Alpine; Teton Mountains, August 21, 1894 (No. 1007).

Arabis Nuttallii, Robinson, Syn. Fl. i, 160 (1895).

In valleys but on dry ground.

Horse Creek, June 9, 1894 (No. 218); Pole Creek, June 28, 1895 (No. 1359).

Arabis perfoliata, Lam. Encycl. i. 219 (1788).

Rare; noted but once; Laramie Peak, August 7, 1895 (No. 1628).

Thelypodium integrifolium, Endl. in Walp. Rep. i, 172 (1842).

Very frequent, especially on saline plains.

Lusk, July 21, 1894 (No. 574); Dubois, August 9, 1894 (No. 747); Laramie, August 10, 1895 (No. 1663).

* Determinations in this genus by Dr. B. L. Robinson.

Thelypodium sagittatum, Endl. l. c.

Widely distributed, but only scattering plants.

Wheatland, June 18, 1891 ; Pole Creek, June 2, 1894 (No. 112); Bacon Creek, August 15, 1894 (No. 922).

Sisymbrium virgatum, Nutt. in T. & G. Fl. i, 93.

On sandy ground among the sage brush.

Laramie Plains, June 9, 1895 (No. 1299).

Draba nemorosa, L. Sp. Pl. 643 (1753).

Frequent in wet loam soil in valleys; variable, some of our specimens are the variety *hebecarpa*, Lindb.

Pole Creek, June 2, 1894 (No. 153); Union Pass, August 11, 1894 (No. 854); Centennial Valley, June 9, 1895 (No. 1254); at other times and places.

Arenaria Nuttallii, Pax in Engler, Jahresb. xviii, 30.

Infrequent; noted only at Garfield Peak, July 29, 1894 (No. 675).

Astragalus bodini, Sheld.

Very abundant in meadow lands in the Centennial Valley; August 25, 1895 (No. 1855).

Astragalus leucopis, Torr. Mex. Bound. Surv. 56, t. 16.

Rare; specimens from the eastern part of the state by B. C. Buffum in 1892.

Astragalus Parryi, Gray, Am. Journ. Sci. ii, 33.

Frequent on gravelly hillsides; Pole Creek, June 2, 1894 (No. 101); Centennial Valley, June 9, 1895 (No. 1298).

CORRECTIONS:—

On page 63, line 3 from bottom, read Engelmann's Spruce for Douglas Spruce.

In the *Astragali* some of the names as given in the list of *Pteridophyta* and *Spermaphyta*, which it was intended to give as synonyms, were inadvertently omitted.

New Species and Varieties.

The succeeding list includes the new species, varieties and names as published in this report.

The following have recently been published as new from this state:

Lists of Plants Reported by Other Collectors.

In the succeeding lists such plants are given as have been reported by others from this state but are as yet unrepresented in our herbarium. It is intended to exclude all names that are merely synonyms of those of our own list, but even with greatest care I fear some will get in. Some, while not synonyms, are names of plants that very doubtfully belong to this region at all. On the other hand these lists, undoubtedly, do not represent all that have been reported from this state, but are intended to be complete with respect to the literature at hand. Such references as could not somewhat satisfactorily be verified are excluded, probably too many.

FROM TORREY'S REPORT ON THE PLANTS OF FREMONT'S EXPEDITION, 1842.

Astragalus tridactylicus, Gray, as *Phaca digitata*, Torr. Little Sandy, August 8.

Potentilla Pennsylvanica glabrata, Watson, as *P. sericea glabrata*, Lehm. Sweetwater River, August 4-15.

Sedum rhodiola, DC. Wind River Mountains, August 12-17.

Symphoricarpos vulgaris, Michx. Wind River Mountains, August 13-14.

Aster Novæ-Angliæ, L. Wind River Mountains, August 18.

Aster andinus, Nutt. Wind River Mountains, August 16.

Erigeron salsuginosus glacialis, Gray, as *Aster glacialis*, Nutt. Wind River Mountains, August 16.

Solidago nemoralis incana, Gray, as *S. incana*, T. & G. Sweetwater River.

Helianthus petiolaris, Nutt. Laramie Hills, July 26.

Helianthus Maximiliana, Schrader. Laramie Hills, July 26.

Hymenopappus corymbosus, T. & G. Upper Platte, August 26.

Vaccinum myrtilloides, Hook. Wind River Mountains, August 15.

Dodecatheon Meadia latilobum, Gray, as *D. dentatum*, Hook., Wind River Mountains, August 13-16.

Phlox muscoides, Nutt. Wind River Mountains, August 15.

Gentiana arctophila, Griseb. Sweetwater River, August 4.

Gentiana linearis, Frœl. as *G. pneumonanthe*, L. Laramie River, July 12.

Habenaria leucophæa, Gray, as *Plantanthera leucophæa*, Lindl. Laramie (Black) Hills, July 27.

Spiranthes cernua, Rich. Sweetwater River, August 6.

FROM COULTER'S REPORT ON THE BOTANY OF THE HAYDEN SURVEY, 1872.

Clematis alpina occidentalis, Gray, Teton Mountains, July.

Ranunculus Nelsonii, Gray, Yellowstone Lake.

Aquilegia flavescens, Wats. Yellowstone Lake, August.

Delphinium Menziesii, DC. Teton Mountains, July.

Aconitum Fischeri, Wats. as *A. nasutum*, Hook. Yellowstone Lake, August.

Nuphar advena, Ait. Yellowstone Park, August.

Dicentra uniflora, Kellogg. Teton Mountains, August.

Cardamine oligosperma, Nutt. Teton Mountains, July.

Draba aurea, Vahl. Teton Mountains, July.

Draba nivalis, Lilj. as *D. Stellata*, Jacq. Teton Mountains, July.

Lychnis Drummondii, Wats. Yellowstone Park, July.

Arenaria pungens, Nutt. Teton Mountains, July.

Arenaria verna, L. Teton Mountains, July.

Arenaria laterifolia, L. Teton Mountains, July.

Sagina Linnæi, Presl. Yellowstone Park, August.

Claytonia linearis, Hook. Clark's Fork, August.

Spraguea umbellata, Torr. Yellowstone Park, August.

Dryas octopetala, L. Teton Mountains, July.

Ivesia Gordoni, Gray, Teton Mountains, July.

Saxifraga oppositifolia, L. Teton Mountains, July.

Tellima parviflora, Hook. Teton Canon, Wyo. (?), July.

Heuchera cylindrica, Dougl. Yellowstone Park, August.

Ribes bracteosum. Dougl. Teton Canon, Wyo. (?) August.

Sedum rhodiola, DC. Teton Mountains, July.

Linnæa borealis, Gronov. Yellowstone Park, August.

Townsendia scapigera Eaton, Teton Mountains, July (?).

Solidago serotina, Ait. as *S. gigantea*, Ait. Yellowstone Park, August (?).

Rudbeckia occidentalis, Nutt. Teton Mountains, July.

Crepis Andersoni, Gray, Yellowstone Park, August.

Crepis nana, Richards, Teton Mountains, July.

Vaccinum ovafolium, Smith, Upper Teton Canon, July.
Ledum glandulosum, Nutt. Shoshone Lake, September.
Pentstemon Menziesii, Hook. Teton Mountains, August (?).
Mimulus nanus, H. & A. as *Eunanus Fremonti*, Gray, Crater Hills, August.
Synthyris alpina, Gray, Teton Mountains, July.
Orthocarpus Tolmiei, H. & A. Fort Bridger, by Dr. Leidy.
Lycopus Virginicus, L. Yellowstone Park, August.
Hydrophyllum capitatum alpinum, Wats. Teton Mountains, July.
Nemophila parviflora, Dougl. Yellowstone, July.
Phlox canescens, T. & G. Teton Mountains, July.
Gilia intertexta, Steud. Teton Mountains, August.
Polemonium foliossimum, Gray, Yellowstone Lake, August.
Kochia prostrata, Shrad. Fort Bridger, by Dr. Leidy.
Erigonum salsuginosum, Hook. Fort Bridger, by Dr. Leidy.
Salix reticulata, L. Teton Mountains, July.
Pinus contorta Dougl. Yellowstone Park, August.
Abies Subalpina, Eng. as *A. grandis*, Trail River Mountains, August.
Lemma triscula, L. Yellowstone Park, August
Zannichellia palustris. L. Yellowstone Lake, 1871.
Goodyera Menziesii, Lindl. Teton Mountains, September.
Corallorhiza mutiflora, Nutt. Shoshone Lake, September.
Lloydia serotina, Reich. Teton Mountains and Clark's Fork, July.
Carex rigida, Good. Red Mountain, September.
Carex alpina, Swartz. Uinta Mountains, by Dr. Leidy.
Calamagrostis sylvatica, DC. Teton Mountains, August.
Spartina gracilis, Trin. Yellowstone Park, August.
Pellæa Breweri, Eaton Teton range, August.
Pellæa densa, Hook. Jackson's Lake, September.
Aspidium Lonchitis, Swartz. Teton Mountains, July.
Aspidium spinulosum, Swartz. Teton Mountains, September.

FROM PARRY'S REPORT ON THE BOTANY OF JONES'S EXPEDITION IN NORTHWESTERN WYOMING, 1873.

Aquilegia flavescens, Wats. Yellowstone Park, August.
Aquilegia Jonesii, Parry, Owl Creek range, July.
Delphinium Menziesii, DC. Fort Bridger, June.

Ranunculus occidentalis, Nutt. Little Sandy, June.
Myosurus minimus, L. Snake River, September.
Thalictrum alpinum, L. Wind River range. July.
Stanleya tomentosa, Parry, Owl Creek, July.
Draba ventosa, Snake River Pass, September.
Arabis canescens, Nutt. Sweetwater, June.
Lesquerella (*Vesicaria*) alpina, Nutt. Green River, June.
Capsella divaricata, Walp. Little Sandy, June.
Nasturtium curvisiliqua lyratum, Wats. Yellowstone, August.
Subularia aquatica, Yellowstone Lake, August.
Arenaria Franklinii, Dougl. Wind River, July.
Arenaria pungens, Nutt. Stinkingwater, July.
Arenaria stricta, Wats as *A. Rossii*, R. Br. Owl Creek range, July.
Arenaria arctica, Stev. Owl Creek, July.
Lychnis Drummondii, Wats. Owl Creek, July.
Lychnis Kingii, Wats. as *L. Ajanensis*, Regel. Owl Creek range, July.
Spraguea umbellata, Torr. Stinkingwater, August.
Calyptridium roseum, Wats. Green River, June.
Rhamnus alnifolia, L'Her. Stinkingwater, August.
Lupinus minimus, Dougl. Stinkingwater, August.
Trifolium andinum, Nutt. Ham's Fork, June.
Astragalus ventorum, Grey, Wind River, July.
Astragalus triphyllus, Pursh, Owl Creek, July.
Astragalus simplicifolius, Gray, Green River, June.
Astragalus glabriusculus, Gray, Wind River, July.
Astragalus lotiflorus, Hook. Wind River, July.
Astragalus Geyeri, Gray, Green River, June.
Astragalus flavus, Nutt. Green River, June.
Astragalus pubentissimus, Nutt. Green River, June.
Astragalus glareosus, Dougl. Green River, June.
Astragalus microcystis, Gray, Stinkingwater, July.
Oxytropis campestris, L. Owl Creek, July.
Oxytropis viscida, Nutt. Wind River, July.
Oxytropis lagopus, Nutt. Pacific Springs, June.
Spirea cæspitosa, Nutt. Owl Creek range, July.
Ivesia Gordoni, Gray, Stinkingwater, July.
Heuchera cylindrica Dougl. Stinkingwater, July.
Saxifraga debilis, Engelm. Owl Creek range, July.

Ribes viscosisimum, Pursh, Yellowstone, August.
Ribes bracteosum, Dougl. Wind River, July.
Œnothera andina, Nutt. Green River, June.
Œnothera scapoidea, Nutt. Green River, June.
Zaushneria Californica, Pressl. Stinkingwater, July.
Peucedanum leiocarpum, Nutt. Yellowstone, August.
Cymopterus Fendleri, Gray, Green River, June.
Lonicera cærulea, L. Yellowstone, August.
Kellogia galeoides, Torr. Stinkingwater, August.
Erigeron coccinnus, Gray, Green River, June.
Townsendia spathulata, Nutt. Wind River, July.
Townsendia Watsoni, Gray, as *T. strigosa*, Nutt. Wind River, July.
Townsendia Parryi, Eaton. Wind River, July.
Townsendia condensata, Parry, Washakie's Needles, July.
Bahia (*Schkuhria*) integrifolia, Parry, Wind River Mountains, July.
Rudbeckia occidentalis, Nutt. Snake River, September.
Arnica Parryi, Gray, Yellowstone, August.
Aplopappus suffruticosus, Gray, Yellowstone, August.
Aplopappus multicaulis, Gray, Wind River, July.
Balsamorrhiza Hookeri, Nutt. Pacific Springs, June.
Antennaria dimorpha, Nutt. Green River, June.
Antennaria luzuloides, T. & G. Stinkingwater, July.
Tanacetum Nuttallii, T. & G. Wind River, July.
Artemisia pedatifida, Nutt. Green River, June.
Artemisia spinescens, Eaton, Green River, June.
Artemisia discolor incompta, Gray, Owl Creek, July.
Troximon glaucum parviflorum, Gray, Green River, June.
Stephanomeria paniculata, Nutt. Stinkingwater, July.
Crepis occidentalis, Nutt. Wind River, July.
Laurentia (Porterella) carnosula, Benth. Yellowstone, August.
Ledum glandulosum, Nutt. Yellowstone, August.
Gaultheria Myrsinites, Hook, Yellowstone, August.
Pyrola picta, Smith, as *P. dentata*, Hook. Yellowstone, August.
Androsace Chamæjasme, L. Owl Creek, July.
Douglasia montana, Gray, Owl Creek Mountains, July.
Pentstemon Menziesii, Hook, Stinkingwater, August.
Mimulus nanus. H. & A. as *Eunanus Fremontii*, Gray, Yellowstone, August.

Castilleia breviflora, Gray, Stinkingwater, July.
Gilia pungens, Benth. Green River, June.
Gilia iberidifolia, Benth. Green River September.
Asclepias brachystephana, Torr. Green River, June.
Polygonum imbricatum, Nutt. Stinkingwater, July.
Oxytheca dendroidea, Nutt. Big Sandy, June.
Atriplex endolepis, Watson, Stinkingwater, July.
Grayia polygaloides, H. & A. Green River, June.
Carex aquatilis, Wahl. Yellowstone, August.
Carex rigida, Good. Yellowstone, August.
Carex Hoodii, Boot. Wind River, July.
Carex tenuirostris, Olney, Yellowstone, July.
Isœtes Bolanderi. Engelm. Yellowstone, August.

FROM GRAY'S REPORT ON THE PLANTS OF THE JENNEY SURVEY OF THE BLACK HILLS, 1875.*

Clematis alpina occidentalis, Gray.
Thalictrum dioicum, L.
Aconitum Fischeri, Reichenb.
Lesquerella (*Vesicaria*) alpina, Nutt.
Viola delphinifolia, Nutt.
Helianthemum Canadense, Michx.
Polygala alba, Nutt.
Psoralea esculenta, Pursh.
Astragalus gracilis, Nutt.
Astragalus simplicifolius, Gray.
Lathyrus ochroleucus, Hook.
Sophora sericea, Nutt.
Geum rivale, L.
Rubus triflorus, Richard.
Œnothera pumila, L.
Thaspium trifoliatum, Gray.
Cymopterus glomeratus, Nutt.
Cornus Canadensis, L.
Aster falcatus, Lindl.
Solidago speciosa angustata, T. & G.
Echinacea angustifolia, DC.
Helianthus strumosus, L.
Helianthus petiolaris, Nutt.
Pentstemon grandiflorus, Nutt.
Pentstemon albidus, Nutt.
Verbena bipinnatifida, Nutt.
Lophanthus anisatus, Benth.
Mertensia oblongifolia (Nutt.) Don.
Eriogonum multiceps, Nees.
Lilium Philadelphicum, L.
Prosartes lanuginosa, Don.
Pellæa atropurpurea, Link.
Onoclea sensibilis, L.

* Although the Black Hills are largely in Dakota, yet as the route of the party to and from them lay in this state, and as the flora of the Hills may reasonably be supposed to be approximately the same in both states, these names are included here.

SUMMARY.

In the foregoing lists there have been enumerated from the material in this herbarium 1118 species and varieties of *Phanerogams* (*Spermatophytes*), representing 393 genera. Omitting duplicates from the lists of plants reported by others there are enumerated 177 more, making a total of 1295 thus far reported from this state. This number, undoubtedly, does not do justice to all the work that has been done in the state and falls far short of the number that may be expected when it shall have been thoroughly worked. The northeast and southwest floras are quite distinct from each other and from those portions of the state which have been the most carefully examined. These are yet to be secured.

By way of comparison it may be stated that the following are among the best worked states and the number of species and varieties of *Phanerogams* reported are for Nebraska about 1460, and for West Virginia 1309.

Concerning the *Cryptogams* it may be said that they represent largely an unexplored field. Only 65 species are enumerated in this list, making the total number from this collection 1176 and for the state according to this list 1360. This does not include the Mosses and Lichens of the Hayden report, and possibly other collections may have been omitted.

Duplicates of a large part of the plants enumerated from this collection will be found in the herbaria of Harvard University, Columbia University, Shaw Botanic Garden, National Herbarium, the Vanderbilt collections at Biltmore, N. C., University of Minnesota, Cornell University, and Prof. E. L. Greene's Herbarium.

INDEX TO GENERA.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

BULLETIN NO. 29.

JULY, 1896.

ALKALI:

SOME OBSERVATIONS AND EXPERIMENTS.

BY THE AGRICULTURIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

WYOMING

Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

PRESIDENT OF THE UNIVERSITY OF WYOMING.

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ALKALI:

SOME OBSERVATIONS AND EXPERIMENTS.

B. C. BUFFUM.

The presence in the soil of what is popularly known as alkali is almost universal in Wyoming. In some places the deposits in alkali lakes are of sufficient magnitude to be commercially important as soures of supply of salts of sodium and magnesium. In some parts large areas are known as alkali deserts owing to the low annual rainfall and the presence on the surface of quantities of these salts. The names of many of our streams as "Bad Water", "Poison Creek", "Alkali Creek", "Salt Creek", etc. indicate the presence of alkali, which finds its way into the country drainage from the soil. In some of our best farming districts larger areas are taken each year by the alkali, due to the accumulation of the salts on the surface, being brought from below by the water which evaporates leaving the alkali behind. This condition might be expected upon all of our irrigated farms, but we have some notable exceptions. In the Wheatland district, although the rainfall is too small to produce crops, and all farms are irrigated, no injurious alkali has appeared upon any of the uplands under cultivation.* The soil of the uplands here is colluvial and derived from the earlier geological formations† which do not supply the alkali salts.

*Water used for irrigation at Wheatland comes from the Laramie river and contains enough alkali to deposite large amounts on the land,-see Bul. No. 24 of the Wyo. Sta. Page 117,-on this account alkali will probably appear in places upon these lands in the course of a few years.

†Wyoming Station Bulletin No. 14, pp. 116 and 117.

Other parts of the state in which there is not sufficient alkali to be injurious are the northeastern portion where the annual rainfall is over fifteen inches, the mountains upon which the rainfall is large and the drainage good, and small valleys along streams in or near the mountains, where either the geological formation explains the absence of salts or the alkali has been leached from the soil by the abundance of water in the presence of good drainage, conditions which usually prevail in such places.

The reclamation of alkali lands and the prevention of the alkali taking possession of portions of our irrigated farms along with the effects of these salts upon soil and crops are the problems under consideration, the solving of which is of growing importance. It is upon the farms which are already under cultivation and valuable and those that may become affected that the question of what to do for the alkali is of paramount importance. Farmers cannot afford to have even small portions of their land become partially or entirely unproductive. Farms upon which no alkali is apparent at first, through irrigation, lack of proper drainage, and, perhaps, poor cultivation have given up continually larger areas as waste land, through the salts, which were at first distributed through the soil mass, coming to the surface. The low places where the largest amounts of water accumulate are the first to suffer. Portions of the Laramie and Sheridan Experiment Farms have become barren or unproductive through the rise of alkali. Upon the Laramie Farm the land which shows the most alkali now, produced good crops the first two years of cultivation.

Soils which contain large amounts of injurious salts are generally unusually rich in potash and phosphorus

which are plant foods and will render such land lastingly productive if the injurious salts can be eliminated. This fact has been clearly pointed out by Professor E. W. Hilgard, of the California Station, in his writings upon the subject.

KINDS OF ALKALI.

Alkali, as it occurs in the arid region, consists of one or more salts of sodium or magnesium as the principal ingredient. There are two general forms or classes known as "Black Alkali," and "White Alkali." The difference depends upon the presence or absence of carbonate of soda which forms the black alkali. Large amounts of sodium carbonate occur in the southwestern portion of the state along Green River, and in the central portion north of the Rattlesnake range of mountains. However, upon the greater part of our cultivated agricultural land, white alkali (consisting principally of sulfate) predominates. Hilgard has shown that the presence of alkali in soils is due to climatic conditions, and that the sulfate usually occurs in cold climates, while the carbonate, if formed naturally in the soil from other salts, generally occurs in warm climates, though he cites instances where the carbonate is left in the soil from the decomposition of rocks containing it.* This corresponds with the general conditions in Wyoming—great deposits of sodium sulfate, sodium carbonate and magnesium sulfate have been formed through geological agencies, but the carbonate does not form naturally from other salts in the soil and consequently its occurrence is local rather than general.

*Bulletin No. 3 of the U. S. Department of Meteorology on "Relations of Soil to Climate, and Year Book of Department of Agriculture for 1895.

The white alkali varies greatly in composition. In places it consists of pure sulfate of sodium (Glauber salt), in other localities pure sulfate of magnesium (Epsom salt) is found. Generally white alkali consists of sulfates of sodium and magnesium associated with smaller amounts of sodium chlorid (common salt), potassium chlorid, and calcium sulfate (gypsum). In the same place the composition does not seem to be constant, but varies at different times. The following analyses give the composition of alkali on the Laramie and Sheridan Experiment farms so far as data are available. The first four analyses are computed from water analyses made by Prof. Slosson and reported in Bulletin No. 24 of this Station. The amount of each salt of the alkali and the gypsum is given in per cent of the total alkali, no account being taken of the insoluble matter, silica, iron and alumina and calcium carbonate. The calcium sulfate is reported with the alkali as it is usually present and may account for the absence of black alkali, especially in No. 1, where the salts in the water that ran on the land contained 27¾ per cent carbonate of soda but no gypsum, while the waste water contained 23 per cent gypsum but no carbonate. The sodium carbonate is probably converted into the sulfate as fast as it comes to the soil with the irrigation water.

No. 1.—*Composition of Alkali in Waste Water from Irrigation of July 19, 1894, Laramie Farm. Wyoming Station Bulletin No. 24, page 111.*

Potassium chlorid K Cl	4.247
Sodium chlorid Na Cl	16.681
Sodium sulfate Na_2 So_4	54.684
Magnesium sulfate Mg So_4	1.318
Calcium sulfate Ca So_4	23.073

No. 2.—*Composition of Alkali in Waste Water, Irrigation of October 2, 1895, Laramie Farm. Wyoming Station Bulletin No. 24, page 113.*

Potassium chlorid K Cl	12.358
Sodium chlorid Na Cl	1.976
Sodium sulfate Na_2 So_4	39.722
Magnesium sulfate Mg So_4	42.371
Calcium sulfate Ca So_4	3.573

No. 3.—*Composition of Alkali in Irrigation Water from Little Goose Creek used upon the Sheridan Experiment Farm. Taken September 15, 1893. Wyoming Station Bullelin No. 24, page 118.*

Potassium chlorid K Cl	9.456
Sodium chlorid Na Cl	9.310
Sodium sulfate Na_2 So_4	39.430
Magnesium sulfate Mg So_4	41.804

No. 4.—*Composition of Alkali in Well Water on the Sheridon Experiment Farm. Wyoming Station Bulletin No. 24, page 129.*

Potassium chlorid K Cl	.997
Sodium chlorid Na Cl	.145
Sodium sulfate Na_2 So_4	17.021
Magnesium sulfate Mg So_4	42.736
Calcium sulfate Ca So_4	39.100

No. 5.—*Composition of Alkali Extracted from Soil on the Laramie Farm Containing 2.24 per cent Salts within Two Inches of the Surface. Sample taken Dec. 4, 1895. Analysis made by W. H. Fairfield.*

Sodium and Potassium chlorids	14.39
Sodium sulfate Na_2 So_4	50.16
Magnesium sulfate Mg So_4	20.03
Calcium sulfate Ca So_4	15.41

AMOUNTS OF ALKALI THAT ARE INJURIOUS.

The amount of alkali in the soil that is injurious to crops depends upon its composition, the character of the soil, whether the salts are upon the surface, and the kind of crop grown. Prof. Hilgard states that less than one-tenth of one per cent of black alkali in a clay soil will

render it unproductive.* In the Year Book of the U. S. Department of Agriculture, page 116, he states that, "For the sandy loam of the Tulare Station, the maximum for cereals may be approximately stated to be one-tenth of one per cent for sal soda (black alkali), one-fourth of one per cent for common salt and from forty-five to fifty one hundredths of one per cent for Glauber salt within the first foot from the surface." This shows the sulphate to be the least injurious of the salts of sodium. Further experiments will be necessary to determine the effects of magnesium sulfate in our soils. Our experiments below show that some of the cereals will resist the effects of alkali better than others. For reasons hereafter stated it is doubtful if any of the cereals will produce a profitable crop on soil containing more than one per cent of alkali within the first two inches of the surface. Such land however will produce sugar beets and other crops which thrive in saline soils. So far as our experiments have progressed no crops have been found which will produce profitable returns upon land containing over two per cent of alkali within the first two inches of the surface. Such an amount produces a thin incrustation of the effervescent salts on the surface which only disappears for a few days at a time when the rains carry it into the soil, reappearing again as soon as the surface soil becomes dry.

LINES OF INVESTIGATION.

Our work with alkali naturally falls into the following classification:

2. The prevalence of alkali in the soil and its effect upon soil and vegetation.

*Annual Report, California Experiment Station for 1892, 1893 and part of 1894, page 149.

2. Effect of irrigation upon alkali soils.

3. Reclamation of such soils: (*a*)—By removing the alkali by leaching, growing plants which will take it up and removing the salts with the crop, or, removing the salts by mechanical or other means. (*b*)—By growing useful plants which will thrive and make such soils profitable. (*c*)—Prevention of the accumulation of alkali salts on the surface by proper cultivation, mulching or shading to prevent surface evaporation.

Farmers frequently inquire whether there is some substance which can be added to the soil to counteract the alkali. Converting the white alkali into a less harmful form or counteracting its effect in the soil by the use of other chemical agents seem such a hopeless task that no direct experiments of the kind have been attempted. In California where small per cents of the black alkali occur it may be converted into the white alkali by the use of gypsum or land plaster, the small amount of sulfate being less injurious than the carbonate, the land again becomes productive.

EFFECTS OF ALKALI.

On the Soil.—No attempt will be made to discuss the chemical effects of salts in the soil. Only a general statement of conclusions drawn from our observations and notes can be made here. Sodium carbonate has a much greater puddling effect upon the soil, destroying its tilth, as well as being more corrosive to plant tissues than the other alkali salts.

The water percolating through the soil seeks the lowest land, larger amounts of it are evaporated from the surface in these low places and consequently they are the

first to become unproductive. These salts hold water with more tenacity than do the loose soil particles, and the alkali soil is usually moist long after the surrounding soil is dry. Hilgard states that the white alkali has no puddling effect upon the soil. However I have observed that in low places where the alkali water stands for considerable periods of time the air is driven out of the soil and it loses its floculation and tilth. Where the water stands in these low places it is often of a deep reddish color,. probably owing to humus or humates of the soil being held in solution.

Upon the Laramie Plains in the open and irrigated grass lands occur spots of sandy or gravelly soil from a few feet to several rods in diameter, forming knolls a few inches higher than the surrounding land. These are devoid of grass or other vegetation. When dry weather prevails white incrustations of salts appear upon them. They seem to be natural reservoirs of soil moisture from which evaporation is unimpeded. They are mentioned here as an example of the effects of alkali on different kinds of soil. When these alkali spots are irrigated and properly cultivated to prevent evaporation and reverse the direction of the water movement, letting it drain from beneath, the alkali disappears and all the land becomes productive.

The white alkali does not change the physical condition of the soil to such an extent that it cannot be easily brought into a good state of tilth after the elimination of the noxious salts.

Effects Upon Vegetation.—The presence of such salts seems to affect plants in two ways. Prof. Hilgard says, "The injury to vegetation is caused mainly or wholly

within a few inches of the surface by the corrosion of the bark, usually near the root crown." He points out also that this corrosive effect is not so marked with the white alkali.

While white alkali corrodes plants at or near the surface, our experiments indicate that this corrosion is not the most important injury, especially to field crops which are grown from the seed in alkali soil. The greatest injury is due to the presence of the alkali interfering with the life functions, absorption and probably also assimilation, in the plant economy. A study of our germination tests and pot experiments point unmistakably to such a physiological effect, from, and even before the germination of the seed, to maturity. In small amounts this growth is merely retarded, while in the presence of larger amounts of salts the growth is entirely stopped or the life destroyed.

Effects Upon Seed Germination.—The requisites for the germination of seeds are heat, moisture and air. However, if the seeds be brought in contact with certain salts in the soil germination will be retarded or entirely prevented. The effects of salts in the soil upon seeds and their germination have been studied but little. The only investigations of this kind that have come to my notice are the observations of Hilgard and a small germinating test in the presence of alkali by Mr. C. Colemore, of San Francisco,* and some brief tests with other salts in France last year.†

THE ALKALI EXPERIMENTS.

Germination Test.—Notes upon the Laramie Farm for several years showed a marked slowness of germina-

*Report of the California Experiment Station for 1892, 1893 and part of 1894, page 141.
†Literary Digest of April 11, 1896, page (707) 17.

tion of crops planted on the lower or east side of the farm where alkali has come to the surface. In the spring of 1893 some garden seeds were planted in flats in the house. A part of the soil used was leaf mold from the mountains and a part ordinary soil from the farm containing small amounts of salts though not enough to prevent crops growing. Seeds of varieties of celery planted in the soil containing small amounts of alkali were several days longer coming up than those in the leaf mold. These observations led us to plan an experiment upon seed germination in the presence of alkali. Thanks are due Prof. Slosson and others in helping to plan and carry out the following experiments as well as to W. H. Fairfield, who did a large part of the work.

In order to know and control all conditions of soil, heat, moisture, etc., this work was carried on in the greenhouse. The condition of the soil was made the same, as nearly as possible, as would occur naturally in the field. The soil plats consisted of graniteware pie plates containing 300 grams of soil. The soil for the experiment was taken from acre plat 11 on the Laramie Farm. The surface was covered with a white incrustation of alkali and supported no vegetation excepting a few weeds belonging to the Chenopodiaceæ. The top soil was taken to a depth of two inches which is about the depth of shallow planting of grasses and alfalfa. This was carefully mixed and an average sample taken for analysis. The analysis made by my assistant, W. H. Fairfield, gave 2.24 per cent soluble salts composed of 14.39 per cent sodium and potassium chlorids, 50.16 per cent sodium sulfate, 20.03 per cent magnesium sulfate and 15.41 calcium sulfate.

A part of the soil was placed in a large receptacle and washed for a number of days with distilled water until no reaction could be obtained for sufates or chlorids except a small amount of gypsum which occurs naturally in the soil and dissolves so slowly that traces would remain after long leaching. The soil so treated was air-dried, passed through a one milimeter sieve and the moisture in this air-dried soil determined. It contained 2.7 per cent moisture.

After putting the soil into the plates they were covered with sheets of glass to prevent further evaporation. The different per cents of alkali were added to the requisite number of plates. This alkali was made up according to the analysis of the alkali extracted from the same soil and added to the plates in solution. Enough water was added in each case to make the per cent of moisture the same in each, so the soil would contain 25 per cent of moisture when the seeds were planted. The soil in each plate was covered with filter paper nearly the size of the plates. The seeds for the test were all selected under a dissecting microscope magnifying eight diameters. Six thousand seeds were examined in this way and the seeds so selected were as uniform as it was possible to obtain. In some cases one hundred per cent of the seeds so selected germinated. Every precaution was taken to insure the same conditions for each of the plates. The temperature of the greenhouse was kept as nearly uniform as possible and read at regular hours both day and night. The time the seeds were planted was noted carefully. One hundred seeds were planted in each case and to facilitate counting they were laid in regular order, pressed into the soil even with the surface and covered with filter

paper. The glass covers were not removed for the first twenty-four hours after planting.

The counting of the germinated seeds began forty-eight hours after planting. They were recorded germinated as soon as the radical had pushed through the seed-coat and were again counted when the plumules appeared.

As a check upon the extracted soil free from alkali 100 seeds of each kind were germinated between blotters and filter papers, the edges of which dipped into distilled water to keep them moist. These are reported in columns one and two of the tables. To check the germination in extracted soil 100 seeds were germinated in the natural alkali soil containing 2.24 per cent alkali and in extracted soil to which was added as nearly as possible the same amount of salts. In addition to the per cents given in the tables we tried the same tests in seven, ten, and fifteen per cents alkali, but as practically nothing germinated in five per cent and nothing in stronger alkali than this they are not reported.

EXPLANATION OF TABLES.

In tables I to VI the time in days in the first column is the time from planting the seed, the number germinated being counted at the end of each day of twenty-four hours. Ext. soil, means the natural soil taken from the farm which contained 2.24 per cent of salts, but from which all this alkali has been extracted, and in cases where it contains alkali the salts were made up artificially in the same proportion of different salts as occurred in the soil samples taken and added to the soil in the plates in sufficient amount to supply the per cents given. Nat. soil, means the soil as it was taken from the farm, not treated in any

TABLE I.—TURNIPS.

Time in Days.	Ext. Soil, no alkali.		Wet Pads, no alkali.		Ext. Soil, 1 per cent alkali.		Nat. Soil, 2.24 per cent alkali.		Ext. Soil, 2.25 per cent alkali.		Ext. Soil, 5 per cent alkali.	
	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.
2	3		8									
3	16		35									
4	17	15	50	50								
5	64	38	52									
6	68		54									
7	71		55									
8	80		57									
9	82		58									
10	84		59									
11	84		61		2							
12	84		64		2							
13	85		67		3							
14	85		68		3							
15	85		71		4							
16			75		8	8						
17			77		10							
18			81		13							
19			84		20							
21			92		24							
23			93		37						1	
25			93		43						1	
27					45						1	

way. The figures in the columns headed germ. and plum. respectively are the per cents of the seeds which have germinated in the given time and the per cents of seeds which had the pumule or first seed leaf developed so as to appear through the seed coat.

RESULTS OF THE EXPERIMENT.

The merest glance at any of the tables shows that even small per cents of alkali in the soil will retard the germination of the seed, and the larger the amount of alkali in the soil the greater will be the time the seeds will take to germinate, up to the amount necessary to entirely prevent development of the germ. Were this the

TABLE II.—BARLEY.

Time in Days.	Ext. Soil, no alkali.		Wet Pads, no alkali.		Ext. Soil, 1 per cent alkali		Nat. Soil, 2.24 per cent alkali.		Ext. Soil, 2.25 per cent alkali.		Ext. Soil, 5 per cent alkali.	
	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.
2	13		15									
3	68		63	17								
4	89	13	88	44								
5	95	78	92									
6	98		95									
7	98				15		1					
8	98				27		3					
9					81		3		3			
10					86	5	3		3			
11					91	7	18		15			
12					94		19		15			
13					96	16	20		19			
14					97	32	21		21			
15					97		25		26			
16					97		32		28			
17							33		31			
18												
19												
21							34					
23							37	4				
25							42		33			
27							45		34	5		

only effect it would be sufficient to prevent successfully raising crops so affected, on alkali soils. Should seeds remain in the soil two weeks before germinating the soil would often become so dry as to prevent further development and the crop would be lost, or in our short seasons, development would be so retarded as to prevent the crop maturing should the plants grow well after starting. Heretofore it has been supposed that alkali destroyed or injured young plants by corroding them at the surface of the ground. These experiments demonstrate that there is a physiological effect upon the vitality of the seed and plant.

TABLE III.—RYE.

Time in Days.	Ext. Soil, no alkali.		Wet Pads, no alkali.		Ext. Soil, 1 per cent alkali.		Nat. Soil. 2.24 per cent alkali.		Ext. Soil, 2.25 per cent alkali.		Ext. Soil, 5 per cent alkali.	
	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.
2	77	45	70	55	27		10		1			
3	89	77	84	67	53	28	29		1			
4	91	72	87	84	63		35		4			
5	95	85	91		70	48	61	36	17	2		
6	96	93	91		75	51	63	37	20	3		
7	96		91		85	60	62 ?		34	3		
8	96		91		85	69	67	41	34	9		
9	96		91		87	75	75	41	51	15		
10	96		92		89	77	71 ?		51	16		
11	96		92		91	90	79	63	67	35		
12	96		92		91		75 ?		71			
13	97		92		91		82		72			
14	97		93		91		84	54 ?	72			
15	98		93		91		84		73			
16			95		91		87		78			
17					91		88		79		1	
18					91		90				1	
19					91		91		80	40	1	
21					91		91		82		1	
23					91		91		87		1	
25					94		91		87		1	
27					94		92		89		5	

The tables also indicate which of these crops are least susceptible to the influence of alkali. It has long been known that some plants naturally inhabit saline soils as for example, beets, asparagus, "salt sages" or "saltbush" (species of Atriplex), some grasses, etc. The tables also show that some of the cereals are much more immune than others. Rye will grow upon soil containing comparatively large amounts of alkali. Wheat comes next in order, then barley and lastly oats which would produce a very poor crop upon soils containing as much as one per cent of alkali in the first two inches of surface. This is shown both in the germinating test and in the field where

TABLE IV.—OATS.

Time in Days.	Ext. Soil, no alkali.		Wet Pads, no alkali.		Ext. Soil, 1 per cent alkali.		Nat. Soil, 2.24 per cent alkali.		Ext. Soil, 2.25 per cent alkali.		Ext. Soil, 5 per cent alkali.	
	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.
2			1									
3			3									
4			22									
5			37	37 ?								
6	1		62									
7	1		68									
8	42		75		1							
9	65		83		1							
10	72	17	87		1							
11	82	79	89		1							
12	91		89		1							
13	93	81	89		1							
14	94	82	89		13							
15	94		89		14	1						
16	94		89		15	1						
17			89		15	1						
18					15	1						
19					15	4						
21					24							
23					25				1			
25					26				5			
27					34		14*		7 ?			

*Leak in roof allowed rainwater to fall in plate.

small amounts of alkali (less than one per cent in the upper two inches of soil) have prevented profitable crops. Turnips are quite susceptible, while alfalfa will germinate in ordinary alkali soil.

Alfalfa is a valuable hay crop and when once started shades the ground preventing the rapid rise of alkali.

The reason that alkali in the soil retards or prevents the development of the germ is not so easily determined. A study of the seeds planted in soil with five to fifteen per cent alkali indicated that the water did not readily enter the seed. They swelled slowly. The outer seed coat on the wheat and rye seemed to swell faster than the starch

TABLE V.—WHEAT.

Time in Days.	Ext. Soil, no alkali.		Wet Pads, no alkali.		Ext. Soil, 1 per cent alkali.		Nat. Soil, 2.24 per cent alkali.		Ext. Soil, 2.25 per cent alkali.		Ext. Soil, 5 per cent alkali.	
	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.	germ.	plum.
2	18		4		1							
3	36		7	3	2							
4	47	14	25	5	3							
5	60	28	41	16	13							
6	74	49	47		15							
7	82	59	57		17							
8	84	71	73		23							
9	85	75	80		32	10	1		1			
10	85	77	83		34	13	3		1			
11	87	79	87		55	20	4		3			
12	87		89		55		4		3			
13	87		91		55	22	6		3			
14	88		91		55	22	6		3			
15	88		94		56		6		3			
16	92		94		66		7	5	3			
17			94		66	32	14	6	6			
18			94		66		14	6	6			
19			94		67	44	14	6	6			
21			95		67		17		6			
23					68	52	24		8			
25					68		33	15	12			
27					68		33	21	12	3		

inside, leaving it loose and wrinkled. No apparent change could be detected in the germ even when examined under high powers of the microscope. In the alfalfa the seed leaves swelled, cracking open the seed coats, but there was no development of the embryo.

Wheat grains soaked in distilled water and in two and one-fourth per cent solution of alkali imbibed the following amounts of moisture:

Wheat soaked 24 hrs. in distilled water took up 44.182 per cent moisture.
Wheat soaked 24 hrs. in 2.25 per cent alkali solution, 39.942 per cent moisture.
Wheat soaked 96 hrs. in distilled water took up 69.230 per cent moisture.
Wheat soaked 96 hrs. in 2.25 per cent alkali solution, 54.293 per cent moisture.

The alkali seems to produce a physiological effect

into the saucers from which it was again taken up into the soil with the water. Frequent waterings on the surface kept the alkali from accumulating on top of the soil. In addition to the pots which were filled with extracted soil and natural alkali soil containing 2.24 per cent, 3 per cent and 5 per cent alkali a series was filled with garden soil from the farm which contained only one-tenth of one per cent.

The following notes and illustrations give the results of the experiment:

TURNIPS—PLATE I.

Five seeds planted in each pot March 19. Picture taken sixty-five days later.

Pot No. 1.—5 per cent alkali. None came up.

Pot No. 7.—3 per cent alkali. None came up.

Pot No. 13.—2.24 per cent alkali. In six days three up, in seven days four up, in nine days five were up with seed leaves expanded. In eleven days third leaf started, in seventeen days third leaf well developed. At the end of sixty-five days four plants growing. Longest leaves 4¼ inches.

Pot No. 19.—0.104 per cent alkali. In four days two up, in five days four up, in eleven days third leaf well started. In sixteen days third set of leaves started. At the end of sixty-five days four plants with longest leaves from 5 inches to 6½ inches in length.

Pot No. 25.—No alkali. In fourteen days one up. Only one came up. At end of sixty-five days one plant with longest leaves 4¾ inches in length.


1
7
13
19
25


2
8
14
20
26

BARLEY—PLATE II.

Five seeds planted in each pot March 19. Picture taken sixty-five days later.

Pot No. 2.—5 per cent alkali. None came up.

Pot No. 8.—3 per cent alkali. In ten days one plant was up, in eleven days two up, in fourteen days three up ¼ of an inch to 1½ inches high. In twenty-three days from 2½ to 3 inches high. At end of sixty-five days five plants were up, one ⅝ inch high, highest plant 6¾ inches high.

Pot No. 14.—2.24 per cent alkali. In seven days two up, in eight days four up from ¼ inch to 1¼ inches high. In nine days five were up from ¼ inch to 2¼ inches high. In sixteen days from 4½ inches to 5½ inches high. At end of sixty-five days five plants were from 11 to 13 inches high.

Pot No. 20.—0.104 per cent alkali. In six days five seeds were up from 1-16 to ¼ inch high. In sixteen days from 4 inches to 6¾ inches high. At end of sixty-five days five thrifty plants were from 12 inches to 19 inches high. Grain shooting.

Pot No. 26.—No alkali. In six days two up, in eight days three up 1½ inches high, in twelve days four up from ⅜ inch to 5 inches high, in sixteen days from 3½ inches to 6¾ inches high. At end of sixty-five days four plants 18 inches high, shooting.

RYE—PLATE III.

Five seeds planted in each pot March 19. Picture taken sixty-five days later.

Pot No. 3.—5 per cent alkali. None came up.

Pot No. 9.—3 per cent alkali. In eight days one plant was up. Only one seed germinated. In sixteen days 4½ inches high. At end of sixty-five days one plant had grown to a height of 5½ inches and died.

Pot No. 15.—2.24 per cent alkali. In four days two plants up, in five days three up, in six days all five were up. In sixteen days from five inches to 7¼ inches high. At end of sixty-five days five plants from 13 to 17 inches high. Grain in the boot.

Pot No. 21.—0.104 per cent alkali. In four days four were up, in seven days all five were up. One plant injured while small. In sixteen days plants were from 4¾ inches to 8½ inches high. At end of sixty-five days five thrifty plants were from 21 inches to 30 inches high. Grain heading.

Pot No. 27.—No alkali. In four days four seeds up, in seven days five up. In sixteen days from seven to nine inches high. At the end of sixty-five days five thrifty plants were from 22 inches to 30 inches high. Grain heading.


3
9
15
21
27


4
10
16
22

OATS—PLATE IV.

Five seeds planted in each pot March 19. Picture taken sixty-five days later.

Pot No. 4.—5 per cent alkali. None came up.

Pot No. 10.—3 per cent alkali. At the end of twelve days one plant was up ⅜ inch high, in twenty-three days two plants were up 4¼ inches and 8 inches high. At the end of sixty-five days the plants had not increased in height.

Pot No. 16.—2.24 per cent alkali. In eight days one up, in nine days two up. In ten days three up, in twelve days four up. In sixteen days four plants 3 inches to 4 inches high. At the end of sixty-five days four plants 11½ inches to 17 inches high.

Pot No. 22.—0.104 per cent alkali. In six days four up, in seven days all five up ½ inch to 1¼ inches high. In sixteen days from 4½ inches to 5⅞ inches high. At the end of sixty-five days five thrifty plants from 17½ inches to 19 inches high.

Pot No. 28.—No alkali. In seven days three up, in eight days four up, in nine days all five were up. In sixteen days 5½ inches to 7 inches high. At end of sixty-five days five thrifty plants 23 inches high, shooting.

WHEAT—PLATE V.

Five seeds planted in each pot March 19. Picture taken sixty-five days later.

Pot No. 6.—5 per cent alkali. None came up.

Pot No. 12.—3 per cent alkali. In seventeen days two plants up, $\frac{1}{8}$ and $\frac{1}{4}$ inch high. At end of sixty-five days two plants $\frac{1}{2}$ inch high, both dead.

Pot No. 18 —2.24 per cent alkali. In six days one up, in seven days two up, in eight days three up, in nine days four up, from $\frac{1}{4}$ to $2\frac{3}{8}$ inches high. In thirteen days all five seeds up. In sixteen days 1 inch to $6\frac{5}{8}$ inches high. At end of sixty-five days two plants alive, $5\frac{1}{4}$ and $10\frac{1}{4}$ inches high.

Pot No. 24.—0.104 per cent alkali. In five days two up, in eight days three up, in nine days four up. In sixteen days $3\frac{1}{2}$ to 10 inches high. At end of sixty-five days two thrifty and one weak plant $7\frac{1}{2}$ to 27 inches high, shooting.

Pot No. 30.—No alkali. In five days one up, in six days four up. In sixteen days 9 inches to $9\frac{1}{4}$ inches high. At end of sixty-five days four thrifty plants 24 inches high, shooting.


6
12
18
24
30


5
11
17
23
29

ALFALFA—PLATE VI.

Five seeds planted in each pot March 19. Picture taken sixty-five days later.

Pot No. 5.—5 per cent alkali. None came up.
Pot No. 11.—3 per cent alkali. None came up
Pot No. 17.— 2.24 per cent alkali. In four days one up, in five days two up, in six days four up, in seven days all five up. In sixteen days the fourth leaf was showing on all plants. At end of sixty-five days four plants alive, three being fairly thrifty, from $\frac{1}{2}$ inch to 3 inches high.
Pot No. 23.—0.104 per cent alkali. In three days two up, in four days all five were up. In sixteen days the fourth leaf was developed on four of the plants. At the end of sixty-five days four thrifty plants $5\frac{3}{4}$ inches high.
Pot No. 29.—No alkali. In three days three up, in five days all five seeds were up. In sixteen days fourth leaf starting on three plants, one plant had been broken. At the end of 65 days three fairly thrifty plants from 3 inches to 5 inches high.

OTHER WORK.

The second line of investigation given in our classification, viz: The effect of irrigation upon the alkali in the soil has been reported upon by the Chemist in bulletin 24 on Water Analyses. Other work along this line is in progress.

RECLAMATION OF ALKALI SOILS.

(*a*) *Leaching.*—Where the drainage is good the alkali can be removed by flooding with sufficient amounts of water to carry the salts away with the underground flow. This will also undoubtedly remove some of the soluble plant foods, notably potash, but "of two evils choose the lesser." If the noxious salts are eliminated the soil will again become productive. Artificial drainage is probably too expensive to put into general practice in this state at present, but in many cases the natural drainage will be sufficient.

DRAINS UPON THE SHERIDAN FARM.

During the summer of 1895 a series of open ditches was dug around and through an alkali plat upon the Sheridan Farm. They are so constructed that the water in times of heavy rainfall or irrigation will be drained from two feet below the surface. The soil is heavy adobe, or gumbo, underlaid with hardpan. Under these conditions it will take a longer time to reclaim than would a loose soil. Reports this year indicate a marked improvement in the alkali plats the first season after draining. Mr. Lewis, the Farm Superintendent, reports that he believes the land will be entirely reclaimed.

Reclaiming by leaching out the surface would be only temporary relief if the alkali salts occur to great

depths in the soil. Recent investigations by Prof. Hilgard show that alkali in California is practically all within the first four feet of surface soil. This discovery is one of the most important which has been made in regard to alkali and like investigations are now under way by our chemist to determine whether like conditions exist in Wyoming. Undoubtedly many of our alkali deposits extend to considerable depths. Where all the salts are within a short distance of the surface, once removing them will permanently reclaim the land.

(*b*) *Growing Useful Plants.*—Much of our alkali land which will not produce cereals or ordinary farm crops which are susceptible of injury by small amounts of such salts may be made remunerative by growing crops which will thrive under such conditions. Sugar beets will produce good crops upon soil too strong for the cereals or other root crops. Upon the Sheridan Farm White Bokhara clover (Melilotus alba) thrived upon strong alkali soil. This clover is not ordinarily relished by stock. Heretofore I have not recommended it for planting as it spreads rapidly, becoming a weed and has been considered of little or no value except as a bee plant. However, in some parts of the west it is cut young for hay, salted and baled, when it is said to be eaten well by all kinds of stock. Alfalfa will grow upon soils which contain comparatively large per cents of alkali, unless the soil becomes too wet. If those locating upon new farms in alkali districts will plant the lower portions of the farm to alfalfa, by shading the ground and preventing the rapid rise of the alkali, it will prevent these parts of the farm being taken by alkali for a much longer time than would otherwise be the case.

There are several species of "Salt Sage" (Atriplex) native in the state which are relished by stock, and in fact form the principal feed upon many of the ranges. They naturally thrive upon alkali soils and may prove of value to plant upon alkali land on the farm. A plant belonging to the same genus known as "Australian Salt Bush" has proven successful on alkali lands in California and its value for this state is being investigated upon the Experiment Farms.

PREVENTING THE RISE OF ALKALI.

The old saying that an ounce of prevention is worth a pound of cure can be well applied to our conditions of alkali soil. Land which might become unproductive in two or three years, with proper precautions may be made to produce crops for a much longer time. The most important point to observe is the prevention of evaporation by keeping the soil shaded. This may be done by keeping it in some crop, such as alfalfa as recommended above or by mulching. Such mulch may be litter hauled onto the soil or formed through cultivation of the surface, leaving three to eight inches of well pulverized soil on top which will act as as a mulch.

After each irrigation, unless the soil is well shaded by crop, it should be cultivated as soon as it can be worked in order to break up the cappillary action which furnishes water to the surface for evaporation.

SUMMARY.

The white alkali of general occurrence in Wyoming consists principally of sulfates of sodium and magnesium.

One per cent or more of these salts in the first two inches of surface soil will make it unproductive for any but plants which naturally inhabit saline soils.

Small amounts of alkali in the soil retard germination and growth in proportion to the amount present. This effect is physiological.

Alkali soil may be reclaimed by leaching out the salts, where there is drainage naturally or artificially supplied.

The rapid rise of alkali may be checked or prevented by hindering surface evaporation through cropping and proper cultivation.

Plants that thrive comparatively well on alkali soil are sugar beets, White Sweet Clover (Melilotus alba), "Salt Sages" (species of Atriplex), and alfalfa under certain conditions. Rye does better than other cereals.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

BULLETIN NO. 30.

SEPTEMBER, 1896.

STOCK FEEDING EXPERIMENTS AT LANDER.

BY THE AGRICULTURIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

WYOMING
Agricultural Experiment Station.

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PRESIDENT OF THE UNIVERSITY OF WYOMING.

FRANK PIERREPONT GRAVES, A. M., PH. D.

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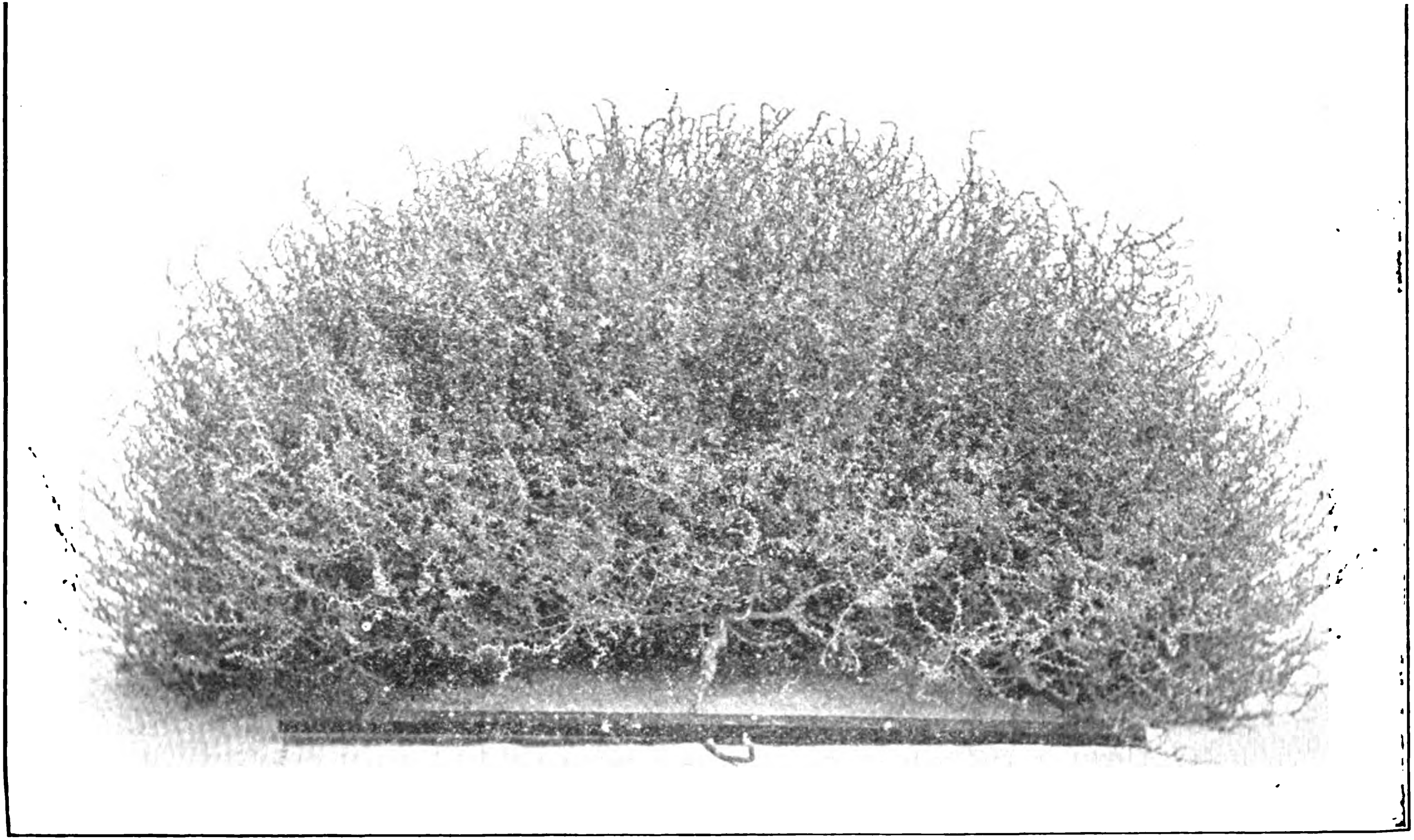
STOCK FEEDING EXPERIMENTS.

B. C. BUFFUM.

The experiments here reported were carried on upon the Lander Experiment Farm during the winter of 1895-'96, under the direct charge of the superintendent, Mr. J. S. Meyer, and his assistant, Mr. H. S. Kendall. The results here presented are computed from the notes furnished by them.

The following is a letter from Mr. Meyer in regard to the general objects of the feeding tests:

"What seems to me to be the object of feeding stock in Wyoming, is to ascertain the cost of having fat stock for the spring months when we cannot depend on the range to furnish us with a good quality of meat. There has been a time when good meat could be killed off the range in any month of the year, but that day has passed. We must now begin to feed our stock for at least the latter part of the winter and the early spring months, to supply our home market. Where shipping facilities are convenient, there should be no reason why Wyoming cannot feed stock profitably for the eastern markets, if by experiments we find we can produce good meats with our grain, hay, and root crops so as to be able to compete with our neighbor corn-growing states. And, while too few of our farmers are figuring on making a profit out of feeding their crops to stock, the time is now



THE RUSSIAN THISTLE (*Salsola Kali Tragus* Moq.) Compact form, showing it as a well developed *tumbleweed*. (Bulletin 55, Ohio Station.)

The Worst Weeds of Wyoming.

AVEN NELSON.

THE NATURE OF WEEDS.

As indicated in the title of this bulletin, it is not the intention of the writer to attempt at this time an exhaustive treatment of the subject of weeds. Its very nature is such as to preclude the hope of saying the final word on this subject. That this must be so is readily understood if we will call to mind what weeds are, and that the term *weed* is largely a relative one. The *weediness* of a plant depends in many cases upon the observer's point of view; that is, a plant is pronounced a weed, *bad* in proportion to the hindrance it offers to the production of that which is at that particular time and place the desirable, or *good*.

It has often been said that a *weed* is only a plant out of place, which may be accepted if we will add that it is one that *insists* on growing where it is not wanted.

It may be well to remember that there were no weeds anywhere till man appeared and found that certain plants could serve for him certain economic purposes. At first such plants as were from time to time found of use, were simply sought out from those places where they had succeeded in maintaining themselves in spite of the severe competition to which all plants in a state of nature are subjected. As these plants or their products became more and more desirable it dawned upon first one and

then another to assist these desirable plants in their struggle for existence. This it was found could be done in two ways; by keeping down the other plants with which these were competing, or by removing the desirable ones into new localities where competition would be less severe.

When this point had been reached in man's struggle with nature, agriculture had its inception, and from that day to this some plants have been favored and others repressed by the hand of man.

On each of these two classes of plants this kind of treatment has produced its legitimate result. The undesirable class has grown more aggressive, holding its ground more stubbornly in each succeeding generation, developing but one quality, namely, that of maintaining and propagating itself under the most adverse circumstances. The desirable class, as it was more and more relieved from the necessity of striving for space, for food and for sunshine, developed its useful qualities to a greater degree, but on the other hand it became less and less fitted to struggle single handed, as it were, with its natural enemies.*

This dependence upon man has been and is still constantly being intensified by man's selective agency. For purposes of propagation those plants are selected which have shown a tendency to produce the desirable product in greater abundance or of more perfect quality, hence it has come about that nearly all plants of economic importance are man's wards, dependent upon him for their

*The oft used phrase, "Struggle for existence," given to us by Darwin, is used as he used it, in a large, metaphorical sense. Not even in the animal world is this struggle often an active combat, but it is none the less real and relentless. If one secures in a legitimate way, by reason of superior endowments, what a thousand need in order to maintain existence but only one can have, the struggle is just as actual, though it is an unconscious one, and the results to those that fail just as inglorious.

very existence, but rewarding him for his care by a superabundance of food materials, superior fibres for his various fabrics, and for his æsthetic sense a wealth of beauty surpassing an artist's dream.

These, then, are the two classes of plants with which the tiller of the soil has to deal, one class representing all those that are at present known to be valuable to man; the other those which to a greater or less extent interfere with the most successful production of the first. To these last in a general way the term *weeds* is applied, but in its more restricted sense the term is applied to the larger or seed producing plants which come into direct competition with our cultivated plants by occupying or attempting to occupy our orchards, our gardens and our fields. Also, as previously suggested, the term has a significance relatively considered. The same plant may at different times be both a weed and a valuable plant. A volunteer crop of buckwheat in a cornfield is no less a weed than a thistle in a hayfield, hence plants cannot all be arbitrarily separated into *good* and *bad*, as the classification of some will depend upon the cultivator's point of view. For our present purposes, then, a weed may be defined as any plant which, by taking possession of the soil, reduces the quantity or quality of the desired crop, or becomes in any way an offense to the eye or an obstruction upon the lands in question.

THE EVOLUTION OF WEEDS.

Thousands of kinds of plants are found growing in greater or less abundance upon the earth. These all strive to perpetuate themselves, some in one way, some in another, but most of them produce seeds or spores which are intended to secure the continuity of the plant's life in

that of new individuals successively produced. It can easily be shown that even the forms which produce the smallest number of seeds per plant, produce enough to cover the whole earth in a few years if each seed were allowed to germinate and develop. What, then, must be the condition when the thousands of kinds of plants, some of which literally produce tens of thousands of seeds, are striving to perpetuate themselves! How fierce must be the competition for place and food! As a result of this struggle for existence, some have adapted themselves to one condition and mode of life and some to another. In the life histories of the races which each represents we see intensified all those variations which have favored them in this fierce combat, not only with other forms, but even with those of their own kind. Those forms which have been able to adapt themselves to the most diverse conditions, to develop the most successful expedients for reproducing their kind and to most surely withstand adverse environments, are the plants which are now our *worst weeds.* These characteristics as displayed in the weeds of the following list will be considered in connection with each.

THE NOXIOUSNESS OF WEEDS.

All who have had any experience with weeds know only too well that some weeds are always an unmitigated nuisance and most of them a constant source of annoyance and financial loss. Few, however, realize to what extent the failure or partial failure to obtain remunerative results in their agricultural ventures is due to the weeds that run rampant in their fields and fence corners. The losses are always occasioned in several ways, among which may be mentioned the following: The weeds crowd out

or shade out the less vigorous plants of the crop, thus reducing the number from which returns may be expected; they abstract from the soil such large quantities of plant food that the crop plants that do survive are not able to attain full development, and so yield inferior products that are unsalable or at best bring but small returns; they interfere with the most expeditious and economic methods of harvesting, and the harvested products, because of admixture with weeds or their seeds, sink still lower in market value; they may cause serious injury to stock, as in the case of Squirrel-tail Grass and some thistles; they may cause serious injury to such animal products as wool by reason of their hooked seeds clinging to and becoming involved in it as do all sorts of burs; the farm itself becomes less and less valuable, and the difficulty of disposing of it greater, for the intending purchaser sees the evidences of an impoverished soil well seeded to weeds. The fences to some extent concealed in the weeds on either side do not create a desire in any one to possess the enclosed acres. That sometimes some use can be made of some weeds does not prove that weeds are a good thing; it may be worth while to save a crop of Rag-weeds in times of scarcity, but it were better to grow something else.

THE PERMANENCY OF WEEDS.

Weeds, like the poor, we have always with us, and again like the poor, they are the most numerous in the most shiftless communities. As shiftlessness causes poverty and poverty induces shiftlessness, so shiftlessness endures weeds and weeds cause poverty now just as they did in the time Solomon. It is possible now as then to go by the field of the slothful and see it all overgrown with thorns and thistles, with the usual accompaniment of the

broken down wall,—all evidences of a little more sleep and a little more folding of the hands. Now, as then, poverty comes to such a place as one that travelleth, and want as an armed man ; but do we, as Solomon, look upon it and receive instruction?

CLASSES OF WEEDS.

With reference to their natural period of life, weeds are spoken of as (1) Annuals, (2) Biennials and (3) Perennials.

The first are reproduced from seed each year, and are easily destroyed, as a rule, by uprooting, and will be eradicated if all the plants springing from a given crop of seed are destroyed. It is well to remember, however, that all the seeds do not germinate the first season. In many cases it is in the nature of the seeds for a part to grow the first and the rest the second year or even later. If the conditions are unfavorable, as lack of moisture or being buried too deeply, they may lie dormant for several years and then spring up, much to the wonder of the farmer as to their origin.

The second live two years, storing up food in the tissues during the first season in order that seed in superabundance may be rapidly produced during the second. These yield to the same methods of extermination as the first.

The third, living for a number of years, are, as a class, the most troublesome. Such perennials as are classed as weeds do not depend upon seeds alone for their propagation. They are provided with underground stems, known according to their structure and form, as rootstocks, bulbs, corms or tubers. These have the power of giving rise to new plants ; and separation from the parent plant,

or even dismemberment of these underground stems, only serves to facilitate the production of new individuals. To this class belong those which most stubbornly resist eradication, as for example the Canada Thistle and Quack or Couch Grass. Many of our worst weeds, however, belong to the other classes, not because the individual plants are hard to kill, but either because of the vast number of seeds produced or the remarkable contrivances for securing their wide dispersal.

For convenience weeds may again be divided into two classes, viz: 1, *Cosmopolitan*, and 2, *Local*. In the first class we will place those which, on account of some remarkable power of propagation or some extraordinary vitality, are at home anywhere and are therefore peculiarly difficult to eradicate. These often require concerted action on the part of communities or states to secure their extirpation and thus avert the loss and annoyance which their complete establishment would entail. In this class we find our worst weeds, but it is to be remembered that such a term can be only a relative one. The worst weeds of one community are not necessarily those of another, for differences in soil, in climate and in character of crops will determine which are most to be feared. In the second class are all other weeds which yield to the ordinary means, viz: cultivation of the ground; in fact, they are rarely found outside of cultivated ground, and if so found are of no particular detriment. This class may very properly be left to individual concern, for the thrifty husbandman will see to it that his crops do not suffer on account of them, and the careless will have to be left to his own folly so long as he does not by his neglect inflict injury upon others.

PURPOSE OF THE BULLETIN.

I do not cherish the Utopian dream that we shall ever be rid of weeds, but there are some kinds that ought to receive the most earnest attention, not only on the part of individuals immediately concerned, but by the State as a whole. It is the purpose of this bulletin to call attention to such, to assist in making them known, to point out the dangers to be feared from each, to help in solving the difficult problems connected with their eradication, and to suggest some needed legislation looking to this end.

In order to secure community of action in this matter it is necessary that the worst pests shall be known and recognized by all. To this end a few of those which, in the judgment of the writer, are at present most to be feared are illustrated and briefly described. As the only object in view is ready recognition of the plant, non-technical language is used, reliance being placed upon the illustrations for enforcing the descriptions. It would be an easy matter to run up a list of a hundred or more weedy plants, but it seems wiser to direct attention to a few very aggressive ones that are weeds first, last, and all the time.

RUSSIAN THISTLE,

(*Salsola Kali Tragus* (L.) Moq.)

As it is intended to consider the weeds of this list in the order of the danger they present to our agricultural interests, the Russian Thistle is placed first, for the danger it threatens is both real and imminent. It has already inflicted untold injury upon the farmers of some of our neighboring States, viz: Nebraska, Iowa, Minnesota and the Dakotas. Several other States are suffering more or

less, but having grappled sooner with the problems of its repression, much has been done in some of them to prevent its securing a foothold. In all of them active measures have been taken, which are doing much to restrict it, even in the worst infected States.

Wyoming cannot afford to delay in this matter; the pest is well established within our borders, and will, in another season or two, be entirely beyond our control. Our climatic and soil conditions are just such as to make this the ideal home of this dangerous tumbleweed.

HISTORY OF THE PLANT.*

The plant seems to be native on the plains of south-eastern Russia, where it has long been a troublesome weed. It found its way into the United States in 1873 or '74, having been brought to South Dakota in flaxseed imported from Russia. The land where it was introduced being somewhat broken, and corn the principal crop, it did not at first spread very rapidly. It was not till about 1888 that it had thoroughly established itself in South Dakota, but about this time it spread beyond her borders and invaded North Dakota on one side and Iowa on the other.

From this time on its dispersal has been rapid beyond all precedent. History records no instance of so much territory invaded by any plant in so short a time, for in these few years it has appeared in nearly all the States from California to New York, and from Canada on the north to Kansas and Colorado on the south.

*Mr. L. H. Dewey, Assistant Botanist of the Department of Agriculture, has studied the Russian Thistle in all of its aspects very carefully. The results of his investigations have been published in Farmers' Bulletin No. 10, 1893; and a much fuller report in Bulletin No. 15 of the Division of Botany. These publications are the sources from which much of the information concerning this weed has been drawn for the now rather extensive literature upon the subject. Several of our Experiment Stations have, however, added greatly to our knowledge of it. All of these sources have been freely drawn upon by the writer, who hereby gratefully acknowledges his indebtedness.

Two causes have contributed to this unapproachable record, viz: first, its peculiar facility in distributing its seeds, naturally on its own account, artificially, by man's aid, in hay, in grain, and in seeds generally; second, suitable soil and favorable climatic conditions. It is just one more instance of the fact that some plants and animals, when transferred to a new locality, find more favorable environments than in their native home. Most of our truly troublesome weeds are of European origin.

ITS HISTORY IN WYOMING.

Though reported from a few points in the State in 1893, it is probable that all such reports were due to persons mistaking other more or less similar plants for the one in question. At least this was so in the cases verified.

Not till the fall of 1894 was an authentic specimen communicated to this Station. This was received from Mr. F. J. Stanton, of Cheyenne, who wrote that it was fairly well established at some points near the railroad. A press bulletin was at once issued sounding a note of warning, which received large publicity through the papers of the State. To this in part may be due the apparent freedom from the weed except along railroad lines, for this placed every suspected weed under the ban.

In 1895 specimens were received from Douglas and Frederics, and this season, 1896, the writer has observed it in a large number of places, in fact at every railroad point visited in a somewhat extended botanical collecting trip.

On the line of the Union Pacific it was plentiful both at Laramie and Cheyenne, at the latter place in all waste ground, sometimes almost to the exclusion of other weeds. On the Cheyenne and Northern, specimens were not rare

at Wheatland, Uva, Badger and Orin Junction. The crop on the Elkhorn at Lusk, and on the Burlington at Newcastle, Moorcroft, Sheridan, Ranchester and Parkman was even more prolific. As these, the only points at which personal investigation was made, were all infected, it seems justifiable to suppose that the weed is found at most points upon all of these lines.

Prof. W. C. Knight, of this Station, reports it abundant at Casper and at various points upon the freight road between that point and Lander, viz: on Poison Spider Creek. At these points it has probably been introduced by seeds in the grain which the freighters have fed at the camping places along the trail.

METHODS OF DISPERSAL.

The Russian Thistle belongs to the class of weeds properly called *Tumbleweeds*. It is not a thistle at all, and has been so called only on account of its spines. It would have been more in keeping to have called it the *Russian Tumbleweed*.

Tumble weeds are plants which usually branch freely, assuming in the course of growth a somewhat spherical form. These plants are annuals, and when mature and dead the one comparatively slender root is easily snapped by the wind and the plant is set adrift, to be threshed over miles of prairie and plain by every storm. On treeless and fenceless areas they travel till worn out, and, as their seeds are not readily dislodged, the thousands* that each plant bears may be distributed over scores of miles. This, while true of all tumble weeds, is especially true of the Russian Thistle.

*A plant of average size, weighing when dry 3 or 4 pounds, it is estimated bears upwards of 30,000 seeds; while the largest, sometimes weighing 20 pounds when dry, bears 150,000 to 200,000 seeds.

But were this the only manner in which its seeds are scattered it would not be so bad, for there are some natural barriers which it would hardly cross. Hay and grain and seeds in general are sent from infected areas, bearing, perhaps, the one seed which serves to infect a new region. Stock cars in their hay and litter carry the seeds from State to State, as evidenced by the fact that almost invariably the points of first appearance are on railroad lines, particularly about stock yards and other places where cars are cleaned from time to time.

SPECIAL DANGER IN WYOMING.

The belief that Wyoming has more to fear from this weed than most of the other States is based upon the following facts : The Russian Thistle belongs to a family of plants, the Chenopodiaceae, of which we have many native representatives. In common with many of these it thrives in all soils, but seems even to be favored by a percentage of alkali. Drought is no hindrance to it ; it matures a crop when all else fails.

Our large areas of unoccupied lands, treelees and unfenced, offer unobstructed and immediate dispersal.

While it is true that it is not able to establish itself in well sodded ground, it is equally true that the open and imperfect sod of many of our native grasses do not resist its encroachments. At several points along the railroads it was observed among Blue Stem and other grasses. Once established on the general range, where it is everybody's or nobody's business to destroy it, it will never be exterminated. Viewed from this standpoint then it cannot be attacked too soon while it is yet, chiefly at least, upon railroad lines and in and about our towns and villages.

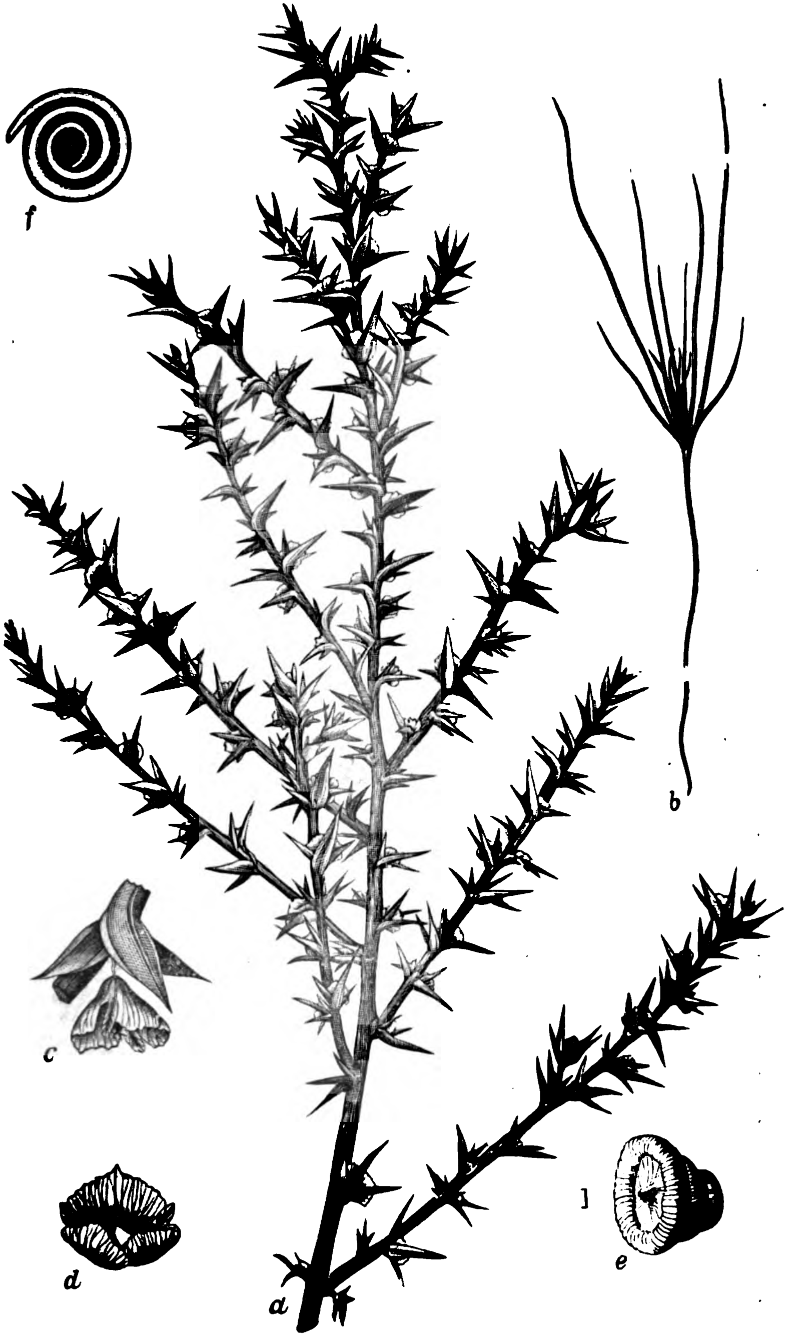


PLATE II.—RUSSIAN THISTLE. Detail figures. For references see description in text. (From Bulletin 15, U. S. Dept. of Agriculture.)

DESCRIPTION.

Technical description is purposely omitted, for I take it that those who are particularly interested wish simply the easiest method of recognizing it. To this end I give the following excellent popular description by Mr. L. H. Dewey, as given in the bulletins to which I have previously referred. The detail figures in Plate II, from the same source, and plates* I and III, will enable any careful observer to recognize the plant.

"In May and June the seeds germinate, each sending up on a slender red stem two narrow green leaves about an inch long and somewhat similar in appearance to shoots of grass. Between these seed leaves a short stem soon appears bearing slender spine tipped leaves, which later produce branches in their axils (Plate II, Fig. b). * * * Until dry weather begins the plants grow rather slowly, but they store up an abundance of moisture in the succulent leaves and branches. During the dry weather in August the moisture disappears from the slender leaves and they wither and sometimes fall off. New shoots are formed which at first are short and densely crowded with spine pointed leaves less than half an inch long, but later elongate so that the leaves become separated at intervals of one-sixteenth to one-half inch (Plate II, Fig. a). Each leaf is accompanied by two bracts similar to the leaf itself, all spine tipped and projecting at almost right angles to the stem. A single, small, stemless flower grows in a cup-shaped depression formed by the bases of the two bracts. The outer parts, or perianth, of the flower are thin and paper-like in texture, spreading, when fully open, about one-fourth inch, and are usually bright rose color (Plate II, Fig. d). If the flower is taken out and carefully pulled to pieces a small, pulpy, green, coiled body appearing like a minute, green snail shell will be found (Plate II, Fig. f). This is the embryo or miniature plant. As the seed ripens its coat becomes of a dull gray color, and at maturity the whole seed is about one-sixteenth of an inch in diameter, irregular in form, and of about one-half the weight of a flax or clover seed (Plate II, Fig. e).

During August and early September the plants become rigid throughout and increase rapidly in size, often growing 2 or 3 feet in height and 4 to 6 feet in diameter, forming a dense, bushy mass of spiny branches (Plates I, III, and Plate II, Fig. a). By the middle of September the exposed parts of the plants have usually changed in color from dark green to crimson or rose red. When the ground is frozen in November the entire plant, except the seed, dies. The root is broken by

*The frontispiece, Plate I, has kindly been loaned to this Station by the Ohio Station; and for the use of Plate III we are indebted to the Wisconsin Station.

the force of the wind and the plant is blown about by the wind as a tumbleweed."

ITS PERNICIOUSNESS.

The Russian Thistle has no good points worthy of consideration. Some claims have been made for it as a forage plant, but its value in that direction should have no weight whatever when it is understood that it has no advantage over many others with no noxious qualities. It cannot be eaten by stock on the range except during the summer months (June and July), when other palatable feed is abundant.

In cultivated grounds it is a weed first, last, and all the time, robbing the soil and crowding out the crops. This is especially its history in grain fields, where it not only greatly reduces or exterminates the crop, but greatly impedes the process of harvesting, damages the machinery, and injures the horses' legs to such an extent as to form festering sores.

The large, rigid plants greatly interfere with all farm operations, and the dry plants, when banked against fences, corrals and stock yards offer inviting pathways for chance fires.

METHODS OF CONTROL.

It is an annual, hence if plants are not allowed to produce seed it will soon be brought under control.

It is not difficult to kill ; if plowed completely under or if cut down with a hoe it dies ; if mowed off below all of its branches at proper times it will suffice. If cut or mowed after blossoming the seeds are often matured from the sap of the somewhat succulent stems, hence all plants approaching maturity must be burned to make sure that they will not distribute any seed.

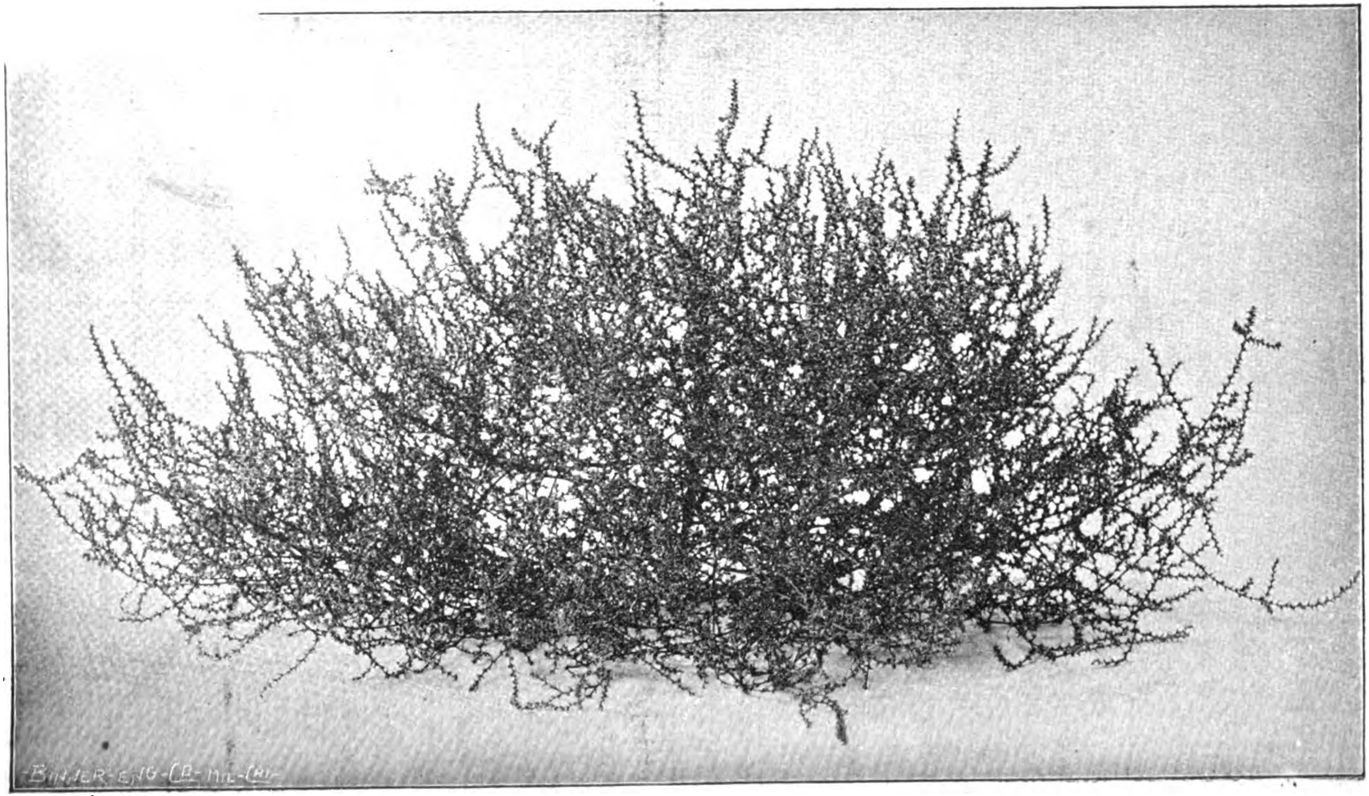


Plate III.—Russian Thistle. Usual form.

As it is rather inconspicuous when young, but develops rapidly and to such enormous proportions late in the season, cultivated, and in fact all suspected areas need to be gone over in late August or early September to see that no isolated individuals have been overlooked.

Vigilance, and the free use of the plow and harrow, the hoe and the scythe, will soon rid a farm of it, but unless there is the completest co-operation of all the residents of a community the ground will soon be re-seeded again. It is just as essential to its extermination that my neighbor shall destroy them on his place as that I destroy them on mine. This will not happen till we have a thoroughly aroused public sentiment, backed by a just and enforceable law. To secure this sentiment it should only be necessary to make thoroughly known the character of the weed and the dangers that it threatens, and to furnish means for its recognition. On these points it ought to be made impossible for any one to remain in ignorance. As Mr. L. H. Dewey has said*, "make the pupils in the schools familiar with it, teach them to destroy it, as they would a rattlesnake, wherever they see it." Let the watchword be: "*Kill it.*"

When it is known that in some counties in our neighboring States this pest is in such complete possession that many farmers are abandoning their fields in despair, and that farm valuations on account of it are greatly diminished, it ought to spur us all on to secure its extermination in Wyoming while it may yet be within our control.

*Farmers' Bull. No. 10, U. S. Dept. Agriculture.

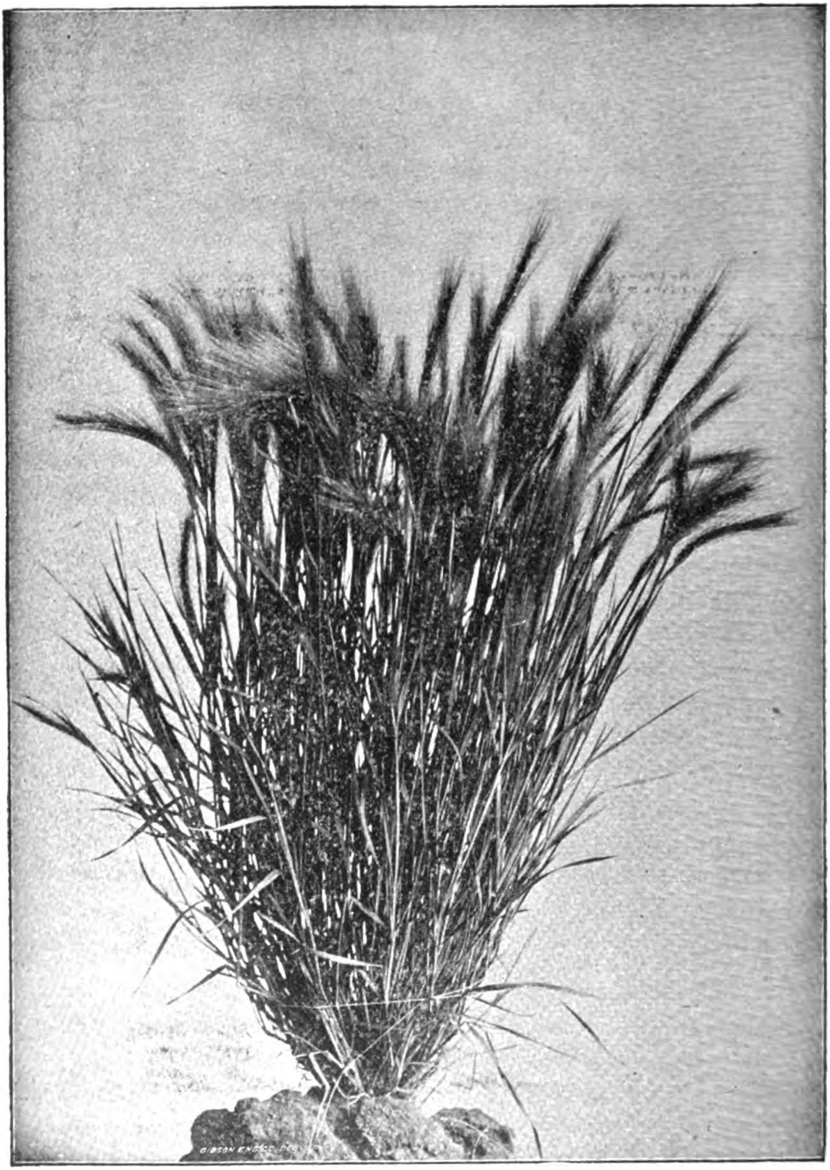


PLATE IV.*—SQUIRREL-TAIL GRASS (*Hordeum jubatum* L.)

*This excellent plate, as well as plates V, XI, XII and XIII, we are able to present through the kindness of Prof. Chas. S. Crandall, Botanist of the Colorado Station. The weed conditions of the two States are so similar that we were glad to avail ourselves of the excellent work that had been done for Bulletin 23, "Colorado Weeds," in which these plates first appeared.

SQUIRREL-TAIL GRASS,

Fox-Tail, Wild Barley (Hordeum jubatum L.*)*

In a State where hay forms so staple and important a crop as in Wyoming, the worst weed of our meadaws must receive attention. In the opinion of the writer there is no one weed that so much concerns hay producers and hay users as this. Not because it is ever likely to take complete possession of our lands, as the Russian Thistle threatens to do, but because, so long as it is endured in our meadows, much hay must be quite unfit for use. How any one who knows its worthless character and the injuries that it inflicts upon stock can for a moment think of using hay in which it is found in any appreciable quantity, is incomprehensible. Selfish interests, as well as humane considerations, forbid its use.

This annual grass is, as soon as it heads, a pest and only a pest. Its light seeds, armed with the long barbed bristles, are carried everywhere by the wind, in the waters of our irrigating ditches and on our streams, and even by animals in their hair and wool.

With such easy dissemination the plant readily spreads to all fields where suitable conditions are offered. Unfortunately suitable conditions are often unwittingly created by the ranchman himself. By over-irrigation, particularly during the spring months, the native or cultivated grasses are wholly or partly killed out and the vacated soil is promptly occupied by this hardy indigene.

Being an annual it is not so very difficult to bring it under control. Infested meadows may be cut before the Squirrel-Tail heads, and if they are cut a second time during the season this will practically exterminate it, if fence

corners and turning rows are not maturing plants for the re-seeding of the ground.

Where it is in complete possession of a meadow the safest and best means is to break up the ground and plant to a cultivated crop for a year or two. This is always effective and probably the shortest road to a well-sodded meadow again, for the considerable presence of this weed in any field indicates that the better grasses have run out.

In this State there are many valuable meadows of native grasses which are being ruined by injudicious methods of irrigation. Constant flooding drowns out the better grasses, which are then replaced by seeds and rushes, or, worse yet, by Squirrel-Tail Grass. It is to be hoped that more judicious methods may prevail, and that the remarkably nutritious native grasses may still be saved in many meadows.

No description of this is needed ; it is known to all, or if not, may easily be recognized from the accompanying plate.

More complete information as to the structure, the mode of dissemination, the injuries resulting from this weed and the best methods of exterminating it, can be obtained from a bulletin by the writer*, No. 19 of this Station, and from one by Prof. L. H. Pammel†, of the Iowa Station.

COCKLE,

Cow Herb (Saponaria vaccaria L.*)*

Cockle is known to all the farmers of this State by name at least. Many have learned to know it at sight by reason of much bitter experience. This is at present the

*Squirrel-Tail Grass (Fox-Tail), One of the Stock Pests of Wyoming.
†Bulletin No. 30, Expt. Station, Ames, Iowa.

PLATE V.—COCKLE (*Saponaria Vaccaria* L.)

worst weed in grain fields. In cultivated fields it causes very little trouble, as it is as readily destroyed as other weeds ; but in fields of spring wheat, especially, much damage is done by this plant. Springing up with the wheat the latter is crowded out, shaded out, and robbed of the food it might otherwise get from the soil. The result is a greatly reduced crop of inferior quality.

Like most of our bad weeds it is an introduction from Europe, but it is so well established now in this country and in the wheat growing sections of Wyoming that where it came from is only of historical interest. How to keep it out of our grain fields is a practical question, and I think one which can be answered.

This is a case where prevention, rather than cure, must be sought. A field well seeded to Cockle, as well as wheat, is practically beyond redemption. The remedy lies in clean seed on clean ground. This is not so difficult of attainment as many suppose. Suspected seed wheat, if it must be used, should and can be cleaned by screening. This should be sown on clean ground. Let the ground known to be full of Cockle seed be used for cultivated crops till the Cockle has been exterminated. To avoid having to fight and endure loss from it every year see that road sides, fence rows and vacant grounds are not maturing plants and seeds to undo all your other work.

This annual may be known by its smooth, opposite leaves, united by their bases, by its rather large pink flowers in a strongly five angled calyx which becomes much enlarged in fruit. It usually grows 18 inches to 2 feet high and branches above.

These characteristics in connection with the figure of

it (Plate V), will enable any one to determine suspected plants.

CANADA THISTLE,

(Carduus arvensis Robs.*)*

This is one of the true Thistles and not merely one in name. It has been talked of and written of for years throughout the United States, and as a result it has come to be so dreaded that wherever it has appeared relentless war has been waged upon it. This, however, has not exterminated it, but it has kept it in check. That this commendable vigilance against this foe might not relax, many States have placed this in the list of weeds proscribed by law; in fact, it was among the first, if not the first, against which laws were enacted.

This weed is now in Wyoming. The writer found a patch in a stock yard on a farm near Sheridan in July of this year. It was also reported from there, with specimens, in 1895. It is probable that some effort was made to exterminate it at that point, but it is very probable that it has entered the State at other places.

Every one should be on the lookout for this invader, as it is comparatively easy to dig out a few, but when a large area is infested it is a costly undertaking. I use the words *dig out* advisedly, for it cannot be destroyed by ordinary methods.

It is a perennial plant; that is, it lives for a number of years, dying down to the ground only, each year. It is reproduced by seeds, which are furnished with a tuft of hair, that the wind may the more readily carry them long distances. This accounts for the rapidity with which it

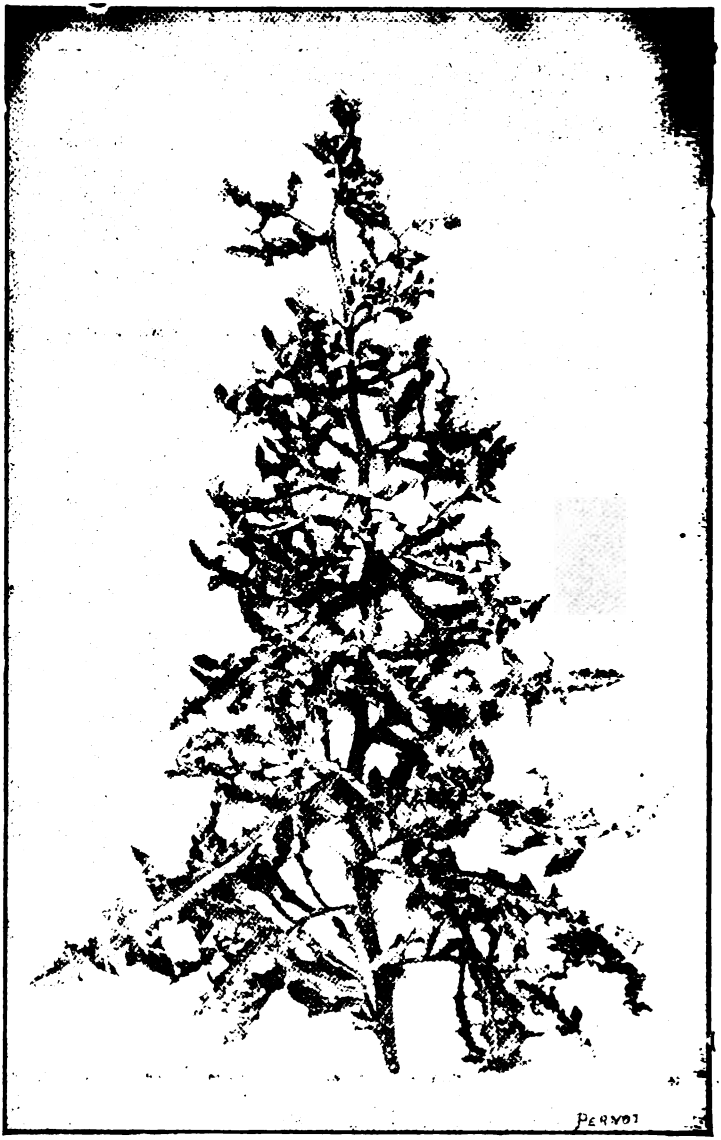


PLATE VI.—CANADA THISTLE (*Carduus arvensis* Robs.) Entire plant, showing habit of growth.

spreads, but the difficulty of killing it out where it has become established is quite another matter. Examination reveals the fact that each plant is furnished with a number of long, slender, underground stems, which at intervals give rise to new above ground stems. This, then, is a second means of reproducing the plant, and gives it its well-known tenacity of life. Ordinary stirring of the soil only increases the number of individuals, as each piece of the broken up underground stems promptly sends up a new shoot.

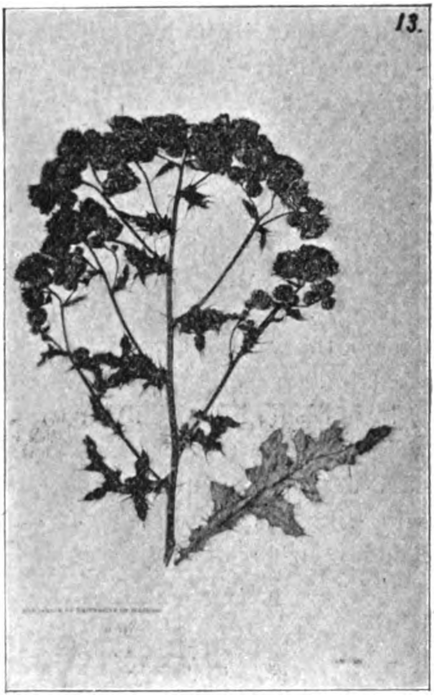


PLATE VII.—CANADA THISTLE. Part of a plant, showing leaf and head more in detail.

It can be destroyed. The first rule is that it must not be allowed to seed, otherwise new areas will be infested by the seeds blown away by the wind. To destroy it where established, if the area be large, recourse must be had to some method of cultivating the soil which shall entirely keep down the above ground parts, thus starving to death the underground stems. All underground parts,

while capable of living for a time without food, ultimately require food prepared for them in the leaves of the plant. Any method then which shuts off this source of supply will be effectual. Repeated plowing may be depended upon, but only an occasional stirring of the soil, especially if the ground be wet, is of advantage to the weed.

In small areas dig them out entire, smother them by building stacks over them, or keep them cut below the surface for a season, or two if necessary.

That all may recognize this weed and attack it at once wherever it appears, two figures are given, one (Plate VI*) showing the plant entire, and the other (Plate VII†) showing some of the heads more in detail.

It grows two feet or more in height, is usually green and smooth, with weak prickles upon the margins of its lanceolate leaves. It branches freely, producing numerous, rather small (one-half inch) heads with rose purple flowers. It may be known from the Bull Thistle, described next, by its underground stems and by the absence of wing-like margins on the stem and of cottony wool on the under surface of the leaves.

BULL THISTLE,

Common Thistle (Carduus lanceolatus L.)

This large, common, roadside Thistle must be familiar to every one. It also has come to us from Europe, and, like the Dandelion, almost keeps pace with civilization. It is introduced into new areas chiefly in seeds, grains, hay, and the packing materials of goods imported.

*Through the courtesy of the officers of the Oregon Station we are able to present this plate of the Canada Thistle, as well as the two of the Bull Thistle.

†For the use of this plate we are indebted to the Illinois Station, as we are also for Plates X and XV, used in this bulletin.

Those not familiar with it may know it by the following description* and figures (Plates VIII and IX).

"It is a biennial, producing the first year simply a tuft of large, spiny leaves spread out flat upon the ground;

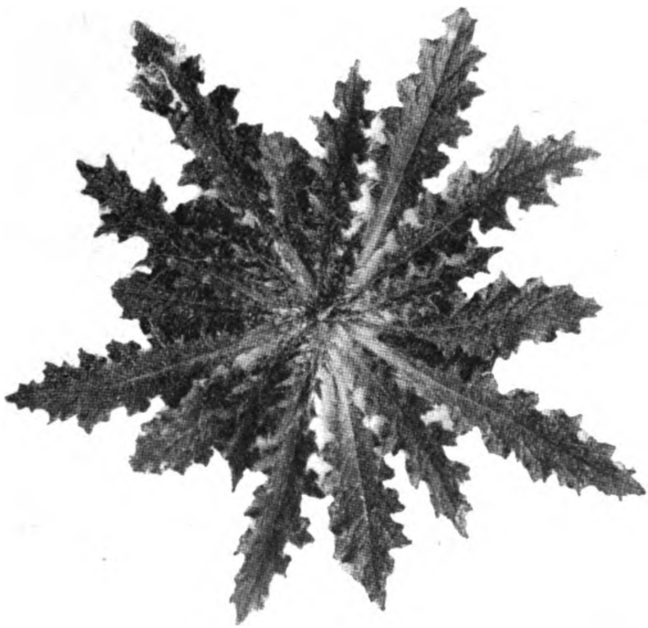


PLATE VIII.—BULL THISTLE (*Carduus lanceolatus* L.) Plant as it appears during its first year's growth.

the second year it sends up a stout, erect, branched stalk, two to four feet high, blooms, bears seed and dies. It may be distinguished from the Canada Thistle by the large flower heads (1 to 1½ inches in diameter), and the wider, stemless leaves, cobwebby beneath, with margins running down the stem as ragged wings, which make the stalks very prickly."

*By Prof. Moses Craig, in Bull. 32 of Oregon Station.

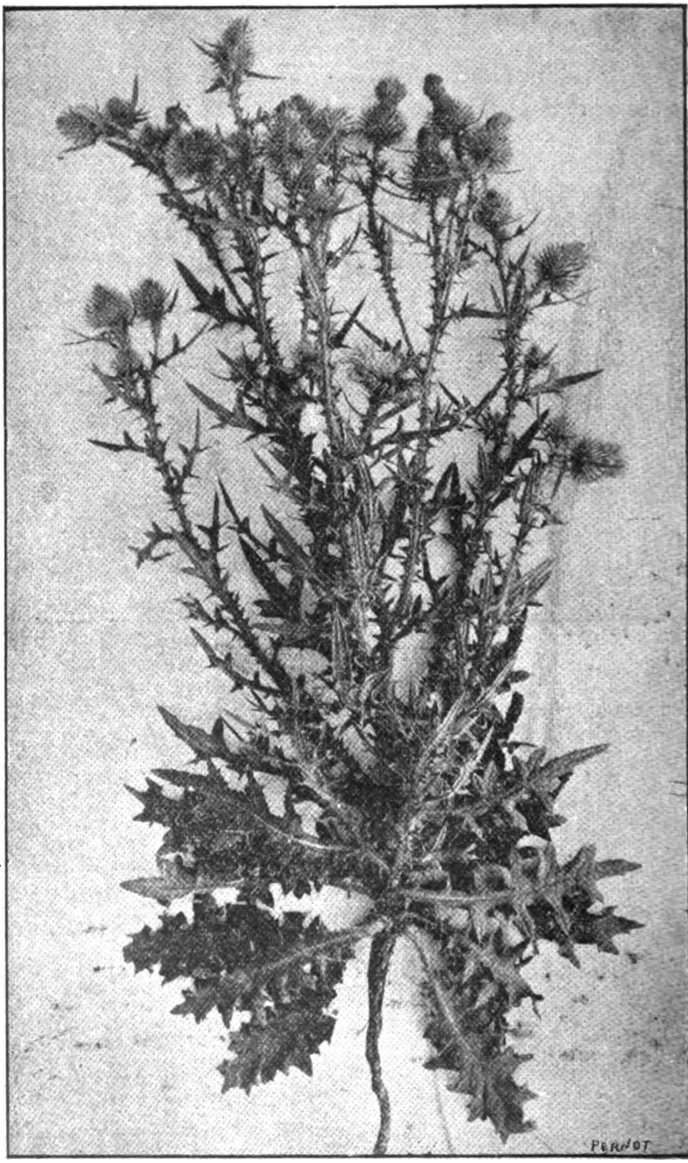


PLATE IX.—BULL THISTLE. Mature plant as it appears the second year.

This Thistle is not so difficult to exterminate as the Canada Thistle, and if no plants were allowed to seed for two years the work would be done. The plants are themselves readily killed, for if cut below the short crown they rarely come up again. This can be done quickly with a tool called, by Mr. L. H. Dewey, a spud*. This is a chisel shaped tool with a long handle. The writer has found a carpenter's stout, narrow chisel effective, but more rapid work could be done with a heavier tool on a long handle. A single thrust ought to suffice to cut the largest plant two or more inches below the surface.

The weed gives no trouble in cultivated ground, but often becomes a nuisance of the worst sort in pastures. The large rosette of leaves and the spreading branches, with their long, formidable spines, not only reduces the productive power of the land, but renders unavailable the grass that does grow, for few browsing animals venture to contest with the Bull Thistle its pre-empted area.

It also springs up along roadsides, in waste ground, and even in lawns, in all of which it produces a most slovenly and unsightly appearance. A few weeds left to fruit in such places will render of no avail what has been done in the field ; the wind catches the seed with its tuft of hairs and whirls it along, possibly for miles, and the new crop of course proves just as troublesome as the first.

*See Farmers' Bulletin No. 10, U. S. Dept. Agriculture.

WILD OR PRICKLY LETTUCE,

Compass Plant (Lactuca Scariola L.*)* Plate X.

Once more Europe has furnished a most vigorous but insidious foe. Though introduced into this country nearly a quarter of a century ago, it is only within the last few years that this tramp has attracted universal attention. In some respects a rather inconspicuous plant, it established itself everywhere before it came under the ban. It is even more widely dispersed than the Russian Thistle, for it has spread from ocean to ocean. In Wyoming, however, it is still rare, only one patch having been observed, viz: on the Cheyenne and Northern, in the Platte Canon. In many other States it has become so abundant that its extermination is no longer considered a possibility*.

It should be an easy matter in Wyoming, where it has no serious foothold as yet, to keep this pest in complete control. It is an annual weed, no more difficult to kill than most annuals, except for the large number of seeds so widely dispersed by the wind.

Prevention of seeding is the remedy, and if the plant is half so troublesome and unsightly as it is said to be elsewhere, the farmers of the State will do well to learn to recognize it. Let the first plants that appear be uprooted before any seeds are mature.

The following points are selected from Dr. J. C. Arthur's bulletin, already cited.

"It is closely related to the garden lettuce, having many of the same characteristics, but with the edge and midrib of the leaf and the lower part of the stem beset with weak prickles. It blossoms in July and August. * * * Correspondents, and writers in the press unite

*See Bull. 52, Vol. V, 1894, of the Indiana Station, Dr. J. C. Arthur.

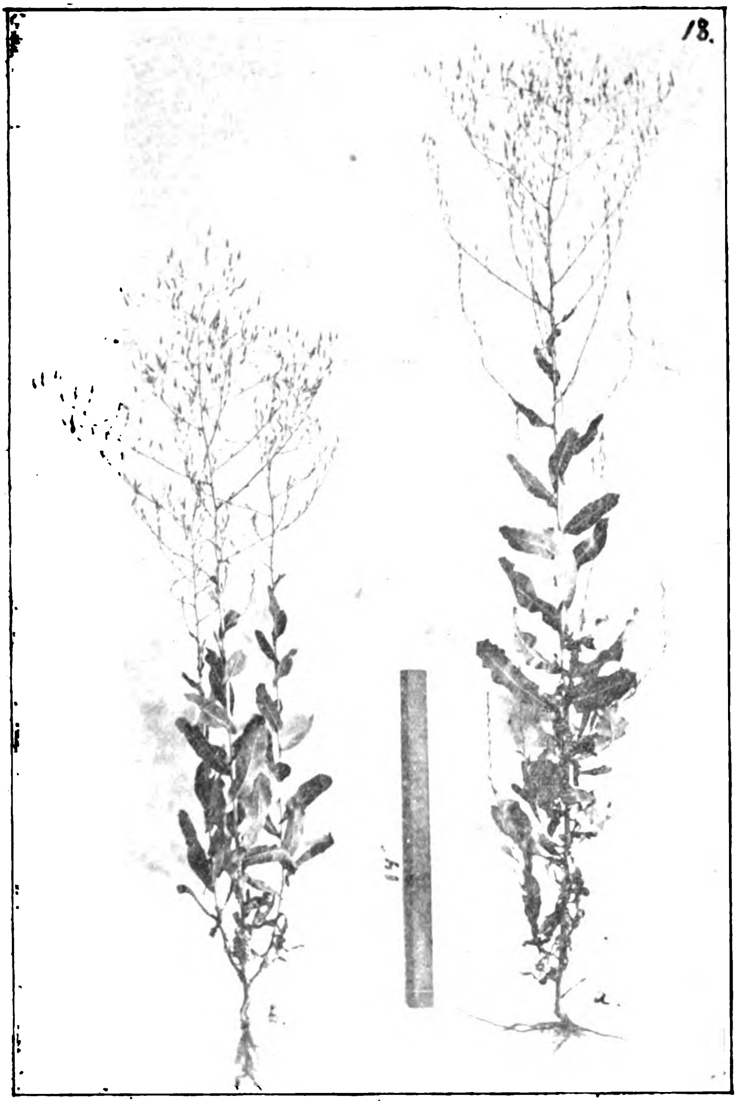


PLATE X.—PRICKLY LETTUCE (*Lactuca scariola* L.) Showing its usual form of growth; also its habit of sending out new shoots if cut off.

in considering this a prominent and disagreeable weed. The plant has many of the qualities of a successful intruder as well as an uncompromising weedy appearance. * * * It becomes an important portion of all weed patches. * * * When the top is injured sprouts are sent out from the base of the stem in a very troublesome manner. * * * The plant has a curious habit of twisting its stem leaves into a vertical position, with the edges directed north and south. It is one of two well marked compass plants. * * * Remember the persistent habit of the plant to throw out sprouts unless cut off below the surface of the ground. * * * A suitable weed law should exist so that dilatory land owners may be brought to action."

BUFFALO BUR,

Beaked Horse-Nettle (Solanum rostratum Dunal.*)* Plate XI.

We will now consider very briefly one of the native weeds which has in other places been very strongly condemned, viz: the Buffalo Bur. It has been observed in several places in the State, usually in sandy ground. From no locality has it been reported as a bad weed, and it is mentioned here chiefly because it has proven that it has weed qualities. It is travelling eastward from the western plains, and in spite of all precautions seems to be establishing itself victoriously in all of the Mississippi valley States. Since it has shown its qualities elsewhere it is just as well to give it no quarter here.

It is a branched annual, one or two feet high, with a rather large lobed leaf. It may be known by the stout yellow prickles which cover both stem and leaf; by the

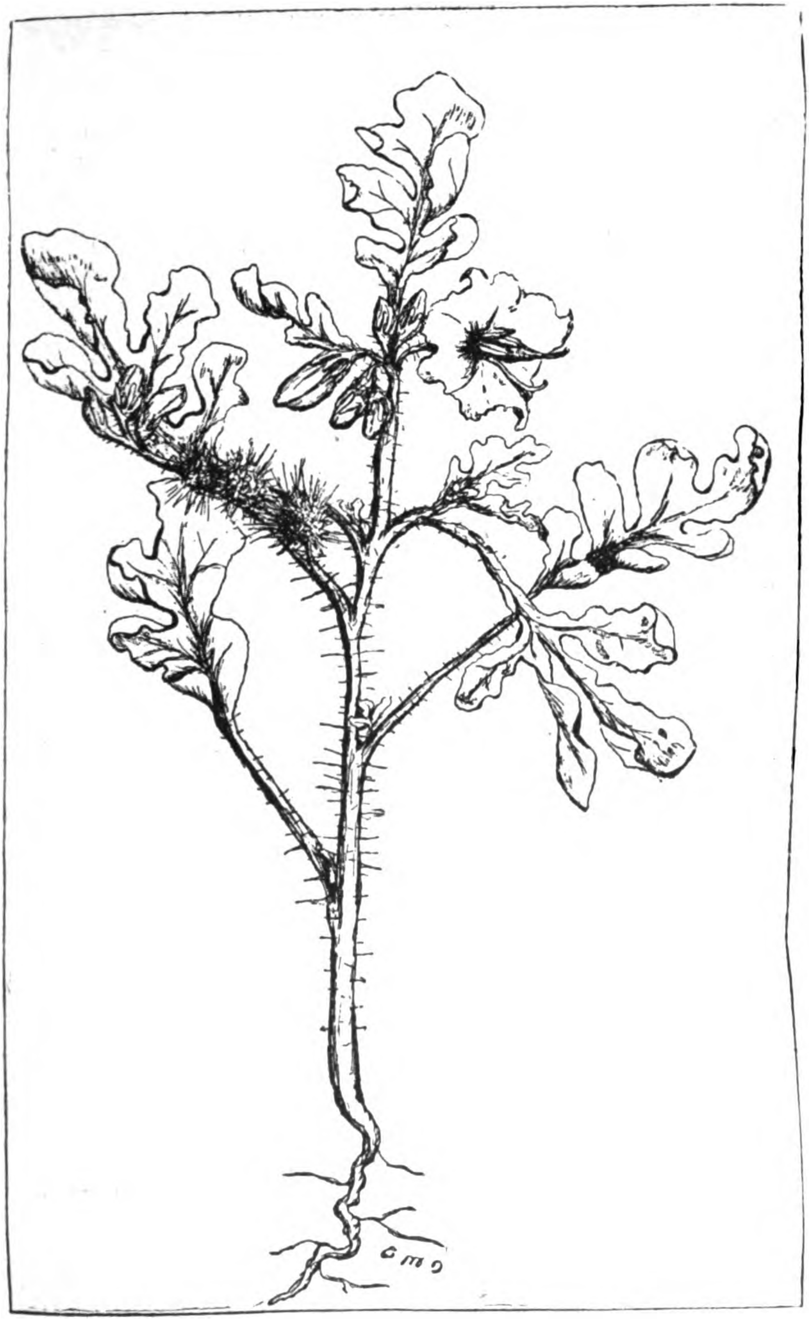


PLATE XI.—BUFFALO BUR (*Solanum rostratum* Dunal.) A small plant.

yellow flowers, nearly an inch across, shaped like the blossom of the tomato and potato, to which it is botanically related, and by the horridly prickly calyx which permanently encloses the fruit. The enlarged calyx with its yellow spines produces a bur-like effect, and explains the origin of its common name.

POVERTY WEED

(*Iva axillaris* Pursh.) Plate XII.

This is a bad weed to get rid of when once introduced, but fortunately it is not generally prevalent. It is a perennial, with running underground stems, the breaking up of which by plowing or hoeing only enormously multiplies the weed. It must be dug out entire or the root stocks starved to death by keeping down all leaves and stems. This can only be done by very frequent cultivation. Infested ground can also be cleared by smothering the weed with heavy seeding to grain or Alfalfa, or better yet, a close sod of the common meadow grasses.

It grows 6 to 10 inches high, branches somewhat and forms dense patches in favorable soil. In the axils of the oblong leaves are produced small, yellow, drooping heads, which produce a moderate amount of seed.

PERENNIAL FRANSERIA,

(*Franseria discolor* Nutt.) Plate XIII.

For this plant no common name is known to the writer, so Perennial Franseria may be adopted. Botanically it stands near the Ragweeds, as does also the Poverty

PLATE XII.—POVERTY WEED (*Iva axillaris* Pursh.)

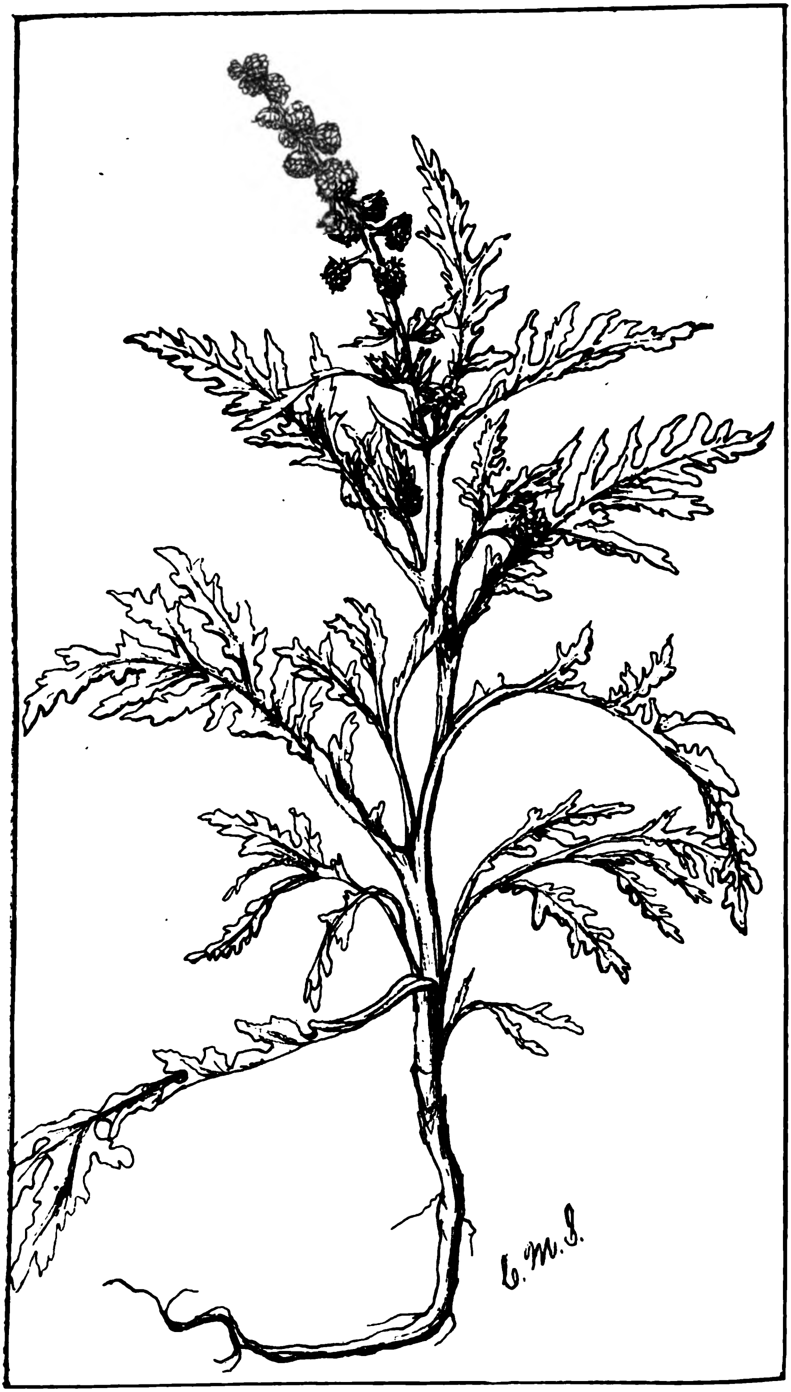


PLATE XIII.—PERENNIAL FRANSERIA (*Franseria discolor* Nutt.)

Weed. Like the Poverty Weed, it is a perennial, and may be compared to that in its mode of life and reproduction. It is more common in the State and still more difficult to eradicate, as it adapts itself to all soils. It has been reported from some localities as defying all attempts to remove it. It readily crowds out all garden or cultivated crops unless hand weeding is repeatedly resorted to. The same methods for its control as for Poverty Weed are suggested. The accompanying plate shows two characteristic plants. They usually grow so densely, however, as to cover the ground as with a mat, and are 4 to 6 inches high. The flower stock overtops the dissected leaves, which are green on the upper surface and whitish beneath.

Another species of this genus *(Franseria Hookeriana* Nutt.*)*, is common in sandy soil, but has not been reported as a weed. It produces a very spiny bur-like fruit.

THE PIGWEEDS

(Amaranthus) Plates XIV and XV.

The Pigweeds, of which there are several species, are found in nearly all cultivated grounds throughout North America. Originally the forms that are now commonest were confined to tropical and western America. These are Thorny Amaranth *(Amaranthus spinosus* L.*)*, Common Pigweed *(Amaranthus chlorostachys* Willd.*)*, Rough Amaranth *(Amaranthus retroflexus* L.*)*, Low Amaranth *(Amaranthus blitoides* Wats.*)*, and Common Tumbleweed *(Amarantnus albus* L.*)*. Only the last three of these are common in Wyoming. and the last two are indigenous. They are all annuals, and attract no particular attention

except in cultivated ground, where, if once established, they furnish seed enough each season for several bountiful crops successively produced, springing up afresh after each cultivation of the land.

PLATE XIV.--LOW AMARANTH (*Amaranthus blitoides* Wats.)
A, Extremity of branch. *B*, A staminate flower. *C*, A pistillate flower.

Of the Rough Amaranth I am unable to present a figure, but it may be known from our other Pigweeds by its erect habit and short, thick, erect spikes, which are almost as long as the terminal one.

The Low Amaranth branches from the base, and has a decided spreading habit, being in many instances quite prostrate. Plate XIV* shows the end of one such branch. In several instances farmers have pronounced this their worst weed.

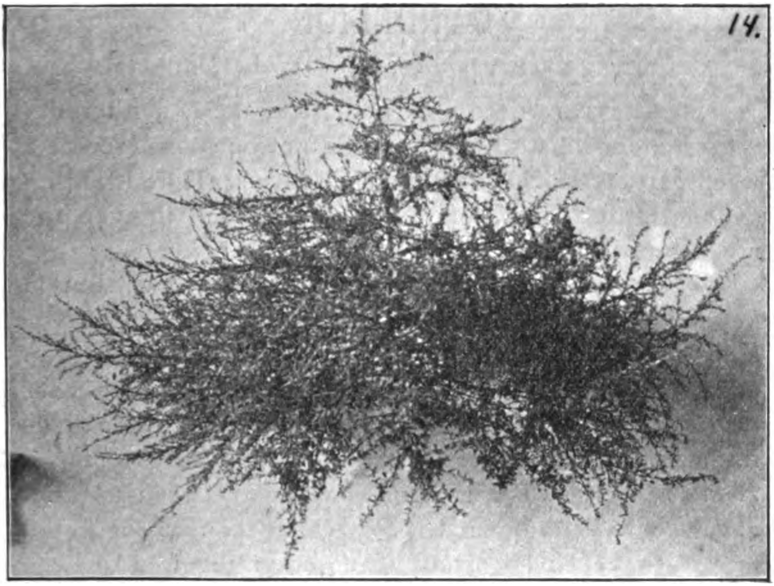


PLATE XV.—COMMON TUMBLEWEED (*Amaranthus albus* L.) This is the plant most frequently mistaken for the Russian Thistle.

The Common Tumbleweed is frequently mistaken for the Russian Thistle, which it closely resembles in form. It may, however, be easily distinguished, for this has flat leaves, the Thistle never has; this has no spines, the floral bracts only becoming somewhat prickly when dry. Plate XV† shows it as a well developed tumbleweed.

*From Bull. No. 21, Nevada Station, through the kindness of Prof. F. H. Hillman.
†This, as well as Plate X, originally appeared in Bulletin No. 39 of the Illinois Station, by the courtesy of whose officers we are permitted to present them here.

The remedy for all of them is clean seed and clean cultivation. Clean cultivation once inaugurated makes each successive year easier and éasier. This self-evident truth applies to other weeds as well as the Pigweeds.

DANDELION

(*Taraxacum officinale* Weber.)

This is known to every one, and needs neither description nor illustration. It need not be considered as a weed but for the trouble it gives in lawns. Here it is preeminently the worst, for it establishes itself in even the most compact sod.

It is easily destroyed by destroying the lawn, but in Wyoming lawns represent too much time and labor to be sacrificed except as a last resort. It could easily be kept in control on individual lawns except for the crop on your neighbor's neglected lot and on the margins of the irrigating ditches in our streets. These furnish seeds enough, all with full spread sail, to re-establish the weed as often as you care to remove it. No remedy can be suggested except that each lot owner be urged or required to keep his own premises clear, including the streets and alleys adjacent to said lots. Until that is done there can be only eternal warfare and no respite from the service. When that is done the contest will soon be an easy victory for the lawn owner.

To remove this perennial from the lawn the best implement is a strong, but narrow (one-half inch) carpenter's chisel. With this the rootstock can be quickly cut some inches below the surface without injury to the grass. Unless cut low in the ground it comes up again.

Various remedies have been tried, such as salt, coal oil, etc., applied to the cut rootstocks, but, besides being too much labor, it is unsatisfactory at best. Unless applied in large quantities it is not effectual, for the Dandelion is hardier than the crop, and large quantities, besides being expensive, kill the lawn as well as the weed.

Plants cut out when in bloom should be burned, for otherwise they even then mature their seeds and send them off on every breeze.

To those in other States who may read this I will state that in Wyoming the Dandelion has apparently found its most congenial home. It is here in full growth and blossom from early spring till late autumn.

A Half Century of Weeds.

While it does not seem best to consider any more of our weeds in detail at present, it may be worth while to make record of those that have attracted some attention within the State.

Enumerating first those already discussed without further comment, the others follow with the very briefest data*.

1. **Russian Thistle** (*Salsola Kali Tragus* Moq.)
2. **Squirrel-Tail Grass** (*Hordeum jubatum* L.)
3. **Cockle,** Cow Herb (*Saponaria Vaccaria* L.)
4. **Canada Thistle** (*Carduus arvensis* (L.) Robs.)
5. **Bull Thistle,** Common Thistle (*Carduus lanceolatus* L.)
6. **Wild or Prickly Lettuce** (*Lactuca scariola* L.)
7. **Buffalo Bur,** Beaked Horse-Nettle (*Solanum rostratum* Dunal.)
8. **Perennial Franseria** (*Franseria discolor* Nutt.)
9. **Pigweeds** — Rough Amaranth (*Amaranthus retroflexus* L.)
10. **Pigweeds** — Low Amaranth (*Amaranthus blitoides* Wats.)
11. **Pigweeds** — Common Tumbleweed (*Amaranthus albus* L.)
12. **Dandelion** (*Taraxacum officinale* Weber.)
13. **Poverty Weed** (*Iva axillaris* Pursh.)
14. **False Flax** (*Camelina sativa* Crantz.)
    Troublesome in grain, observed but once, Parkman, July, 1896.
15. **Skeleton Weed** (*Lygodesmia juncea* Don.)
    Grain fields and cultivated grounds; perennial, dig it out, common.
16. **Wild Tomato** (*Solanum triflorum* Nutt.)
    Very annoying in gardens and truck patches; annual, prevent seeding.
17. **Dock,** Sour Dock (*Rumex salicifolus* Wienm.)
    In meadows, perennial, hard to eradicate; dig out, prevent seeding.

*For brief notes upon these and other weedy plants, as to locality, date of collection, etc., see Bull. 28, First Report on the Flora of Wyoming.

18. **Purselane,** Pusley (*Portulaca oleracea* L.)
Becoming common in rich field and garden soil; Sheridan and Wheatland, July, 1896.

19. **Common Crab Grass,** Polish Millet (*Panicum sanguinale* L.)
Troublesome in garden crops, perennial; "hit it with a hoe."

20. **Great Ragweed** (*Ambrosia trifida* L.)
Margins of fields, fence corners and yards, unsightly; mow it.

21. **Mallow** (*Malvastrum coccineum* Gray.)
Cultivated ground and door yards, perennial; dig it out.

22. **Prickly Pear Cactus** (*Opuntia polyacantha*, several varieties.)
A nuisance on the range and in pastures; cultivation and water kills it.

23. **Bur Grass,** Sand Bur (*Cenchrus tribuloides* L.)
Sandy ground; prevent seeding by clean cultivation.

24. **Dodder** (*Cuscuta*, several species.)
Troublesome in Alfalfa and Flax; remedy, rotation of crops.

25. **Green Fox-Tail** (*Setaria viridis* Beauv.)
In cultivated grounds; pull up and prevent seeding.

26. **Sunflower** (*Helianthus annuus* L.)
Waste ground; plow under and prevent seeding.

27. **Cockle Bur** (*Xanthium Canadense* Mill.)
Cultivated ground, southeastern part of the State, annual; clean cultivation the remedy.

28. **Sow Thistle** (*Sonchus asper* Vill.)
Reported as spreading at Evanston; prevent seeding.

29. **Yellow Flax** (*Linum rigidum* Pursh.)
Grain fields; rotation of crops, clean culture.

30. **Hedge Bindweed** (*Convolvulus sepium* L.)
Still rare, Cheyenne; thorough late cultivation.

31. **Wild Oats** (*Avena fatua* L.)
Not uncommon in oat fields; clean seed, rotation of crops.

32. **Wild Buckwheat,** Black Bindweed (*Polygonum convolvulus* L.)
Common in grain fields and truck patches; clean seed and cultivation.

33. **Lamb's Quarters** (*Chenopodium album* L.)
Common in all cultivated grounds; clean cultivation.

34. **Ragweed,** Roman Wormwood (*Ambrosia artemisiæfolia* L.)
Laramie, Cheyenne, Sheridan; in grain fields and cultivated ground.

35. **Rib Grass,** English Plaintain (*Plantago lanceolata* L.)
Reported only from Lander; clean seed and prevention of seeding.

36. **Porcupine Grass** (*Stipa comata* Trin.)
An annoying and worthless grass.

37. **Poison-Weed,** Larkspur (*Delphinium Geyeri* Greene.)
Very abundant in places. This is the plant which hungry cattle sometimes eat voraciously, in which case it often causes fatal bloating.

38. **Loco,** Loco-Weed (*Oxytropis Lamberti* and its varieties)
Very common, said to cause the peculiar mental disorder in horses known as "loco."

39. **Gum Plant** (*Grindelia squarrosa* Dunal.)
Troublesome in lawns and meadows; prevent seeding.

40. **Wild Mustard** (*Brassica sinapistrum* Boiss.)
Only single specimens observed. A bad weed, pull it out.

41. **Shepherd's Purse** (*Capsella Bursa-pastoris* Medic.)
42. **Rocky Mountain Bee-Plant** (*Cleome integrifolia* T. & G.)
43. **Wild Liquorice** (*Glycyrrhiza lepidota* Pursh.)
44. **Stick-Seed** (*Echinospermum Lappula* Lehm)
45. **Goose Grass,** Door Grass (*Polygonum aviculare* L.)
46. **Perennial Ragweed** (*Ambrosia psilostachya* DC.)
47. **Spanish Needles** (*Bidens frondosa* L.)
48. **Marsh Elder** (*Iva xanthifolia* Nutt.)
49. **Pepper Grass** (*Lepidium apetalum* Willd.)
50. **Wormwood Sage** (*Artemisia biennis* Willd.)

Suggested Weed Legislation.

AVEN NELSON.

THE SITUATION IN WYOMING.

Wyoming has a weed law*. Is it effective? Let the facts in regard to the Russian Thistle and other weeds set forth in the preceding pages answer.

Wyoming needs some new weed legislation *now* if it is to be of the greatest possible service to the State. We may need such legislation more some years hence, just as he who is seriously ill needs a physician more than he who has the incipient stages of the malady. Prevention is always better than cure, but when a physician must be called the chances for the patient are better if he be called promptly. Vast sums of money are being expended in other States to cure an evil which is, so to speak, only at our threshold. Prompt action, with the expenditure of only a nominal sum, will do much to protect us against the weed foes which are just beginning to make themselves felt.

The notion has long prevailed that this is a grazing State solely, that the flocks and herds run on the open range, and that these, with the mines of our mountains, constitute our wealth. It is time for such notions to cease. Our agricultural interests have had a marvelous development. In some counties they are paramount, and in all equal to any other single interest.

The open range stock business, with its hazards, is

*Session Laws of 1895. Russian Thistle and Canadian Thistle are proscribed. No method is provided for bringing this fact before the people or the officers concerned; neither are any means suggested by which these plants may be recognized. The act is printed in full at the close of this bulletin.

giving place to more conservative methods. Smaller, but more numerous herds, individual rather than company ownership, pastures accessible from the ranch or farm, hay and feed during severe weather, are changes which are placing this interest upon a safe business basis. As this comes to be the status of affairs, farming, with all that that implies, is inseparable from it. Let our mines develop beyond the expectation of the most sanguine, our agricultural interests, in the inclusive sense of the term, must yet be the source of much of our wealth. In this vast empire of 100,000 square miles there are other interests than those of the mines and the old time range stock business. Let him who doubts this visit the different counties, and he will see many prosperous and happy homes on well kept farms. The prosperity of our farmers is inseparable from that of the State Let their interests be conserved by legislation which will not leave them to fight their weed foes unaided. Several lines of railroad are operated within the State, and it is to be hoped that we shall soon have more. Inseparable adjuncts of civilization as they are, they are also, for reasons previously stated, the principal means for the introduction of new weeds into the State. Let it be said, however, to the everlasting credit of railroad corporations, that they have shown themselves more ready to comply with the spirit of weed laws than have many individual citizens. It is hardly to be expected, however, that said corporations will concern themselves with what is never called to their attention.

The danger points at present are not the ranches and farms, but the right of way of the railroads, our public highways, and especially the vacant grounds in our towns and cities. All of these danger points may be guarded if

the matter is officially brought to the notice of the parties concerned.

LEGISLATION.

It may be objected that with so much unoccupied territory weed laws cannot be enforced, but as I have endeavored to show it is not the unoccupied territory that is the source of danger. It is this unoccupied territory, as well as our fields and farms, that we would protect.

No one thinks for a moment that weeds can be legislated out of existence, but there are two or three of foreign introduction that the State as a whole is interested in repressing, and that, by united action, can be kept in subjugation. Grain growing communities cannot afford to admit the Russian Thistle, neither can those who are interested in pasture and range grounds afford to permit its occupancy of these.

A large majority of the States and territories have laws relating to certain weeds. Every year of late sees one or more ot those without such legislation falling into line. No State has ever repealed such legislation except to substitute more timely acts for those repealed. Judging by these facts one infers that such laws have been found profitable elsewhere. This State needs such safeguards more than the compactly settled commonwealths.

Mr. L. H. Dewey, Assistant Botanist to the Department of Agriculture, has for several years been studying the weed question in all of its aspects. The weed legislation of the several States has come in for its share of attention. He has personally investigated the operation of said laws in respect to the objects sought to be attained. After such study of the whole subject he has published*

*Legislation Against Weeds, Bulletin No. 17, Div. of Bot., U. S. Dept. of Agriculture.

"a form which outlines the essential provisions of a general State weed law."

This form seems to embody all that is practical in this line of legislation, and has received the endorsement of the chief officials of the Department of Agriculture*.

Taking this form as a basis, and modifying it so as to adapt it to the conditions in this State, having respect all the while to the fact that the expenses attendant upon such a law must be reduced to the minimum, the following form is respectfully recommended to the Legislature of this State for its consideration as a substitute for the present law upon the subject†.

AN ACT FOR THE EXTIRPATION OF SUCH WEEDS AS ARE MOST INJURIOUS TO THE AGRICULTURAL INTERESTS OF THE STATE OF WYOMING:

Be it enacted, etc.:

SECTION 1. A permanent commission, to be known as the State Weed Commission, is hereby created, to consist of the Professor of Botany of the University of Wyoming, who shall be known as the State Botanist, and three eminent farmers or ranchmen, who shall be appointed and commissioned by the Governor, with the consent of the Senate, from among the farmers or ranchmen who may be members of the Legislature during the two years following such appointment. They shall hold their offices for a term of two years, or until their successors are appointed. The Governor shall have power to fill all vacancies that may happen in the commission during the recess of the Senate, by granting commissions, which shall expire at its next session‡.

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*I quote from the letter of transmittal of the bulletin cited: "I have pointed out in my annual report for 1894 the fact that, since the total value of our principal field crops for the year 1893 was $1,760,489,273, an increase of only 1 per cent., which might easily have been brought about through the destruction of weeds, would have meant a saving to the farmers of the nation of about $17,000,000 during that year alone. The passage of effective weed laws, like the one outlined and discussed in this report, is of the first importance in dealing with this problem." This letter was signed by Dr. Frederick V. Coville, Chief of the Division of Botany, and directed to the Hon. J. Sterling Morton, Secretary of Agriculture, who undoubtedly approved of the publication of the bulletin under consideration.

†The original form, of which this is largely a copy, "was carefully revised by a jurist familiar with legal usages and constitutional requirements."

‡For full explanation of each of these sections, with reasons for their several provisions, see the bulletin previously cited. The reason for the suggested composition of the commission is as follows: "The technical knowledge of the botanist and the practical knowledge of the farmers on the commission are needed together to decide what ought to be done and what is really practicable."

SEC. 2. Said commission shall meet biennially at the Capitol on the next week day immediately following the adjournment of the Legislature, and shall be in session for a period not exceeding two days; and for such service each commissioner, who is not a salaried officer of the State, shall be entitled to be paid .... dollars a day for each day's actual attendance at the biennial session; said compensation and the necessary expenses of the commission for stationery, printing and postage shall be paid by the State Treasurer out of any moneys in the treasury, not otherwise appropriated, upon vouchers issued by the secretary of the commission and approved by the chairman.

The members of the commission being members of the Legislature, the short session at its close will not impose upon them any serious hardship, and the cost to the State will be only nominal.

SEC. 3. The Governor shall, when necessary, assign a room at the State Capitol for the use of the commission in which to hold its biennial sessions. Three commissioners shall constitute a quorum. The State Botanist shall be custodian of the records, and, when present, be chairman of the commission.

SEC. 4. Said commission, or a majority thereof, shall determine during its first session what species of weeds, not exceeding three in number, are most injurious to the interests of the State, and shall prepare a list thereof, to be known as Schedule A of this act, which shall state the common and technical names of such weeds and the time or times of year at which they can be most advantageously destroyed, and shall contain a concise description of the best economical methods for their destruction. Said schedule may thereafter be modified at any biennial session of the commission by a majority thereof: *Provided*, That not exceeding the above number of species of weeds shall be included in any biennial schedule.

SEC. 5. When, at its first session, or at any biennial session thereafter, the commission shall have adopted a schedule, or shall have modified one previously adopted, as above provided for, it shall be the duty of the chairman to have a sufficient number of copies of this act, with such schedule annexed, printed and distributed by mail in the following manner: One copy to each State, county and township officer, and one copy to each daily and weekly newspaper published within the State; and the schedule so adopted or modified shall be published in the same manner as the public statutes are published.

"The thorough advertisement of weed laws will do much to secure their observation. Unlike criminal laws, which apply chiefly to men who have little respect for right and justice aside from the fear of penalty, the weed

laws apply usually to men who obey the laws without compulsion by the courts, and in most cases a knowledge of the law will be sufficient warning to enforce its provisions. Copies should be sent to agricultural and other papers for publication, so as to disseminate a knowledge of its provisions as widely as possible among the people."*

SEC. 6. It shall be the duty of every owner, lessee, or occupier of land in this State, and of every owner, lessee, or occupier of any city, town, or village lot, upon whose land or lot any of the weeds named in the schedule provided for in this act shall be found growing, to destroy the same or cause them to be destroyed at or before the time or times mentioned in said schedule, and in the mode therein described, or in such other manner as shall absolutely prevent the ripening and spread of their seed.

"In nearly all cases the land owner can do this work at much less cost than it can be done by the public authorities, and in arable fields it can usually be done in the ordinary operations of cultivation."

SEC. 7. The city marshal in incorporated towns and cities, and the road supervisor in each county are hereby constituted weed inspectors for towns and cities, and for the county outside of such towns and cities, respectively.

SEC. 8. In case of the neglect or failure of any owner, lessee, or occupier of any land or lot within this State to destroy thereon the weeds mentioned in Schedule A at or before the times mentioned in said schedule, any person owning or having in charge any land or lot within the same township may complain in writing, stating the names of the weeds, the location of the land, and the name of the owner, to the road supervisor or the officer having in charge the highways or streets of the township, city or village within which the weeds complained of are growing. In every such case the complainant shall send with his complaint a written agreement to pay the said highway commissioner or other officer above designated his reasonable expenses incurred in the inspection of the land complained of on which any of the weeds mentioned in the schedule are not found. Upon the receipt of such complaint it shall be the duty of said road commissioner, or other officer, to inspect the land or lots mentioned in the complaint, and if any of the weeds mentioned in Schedule A are found growing thereon he shall notify the owner, lessee, or occupier of the land in writing to destroy them, and if the weeds are not destroyed at the expiration of five days after service of notice, he shall employ such labor as is necessary and enter the lands and destroy

*The comments following Sections 5, 6, 10 and 12 are also by Mr. Dewey.

in the most practicable and economical manner (or in the manner prescribed in the schedule) all of the weeds mentioned in the schedule that are found growing thereon: *Provided, however,* That in case there is no resident owner, lessee, or agent responsible for the care of the land the service of notice may be omitted.

SEC. 9. Each road supervisor or other officer, designated in Section 7, shall make an itemized statement, duly verified by oath or affirmation, of the expenses incurred in inspecting each tract of land or lot on which weeds mentioned in Schedule A were found growing, and of all expenses incurred by him for destroying said weeds, which statement shall contain a description sufficient for identification at the office of the county assessor of each tract of land or lot on which such weeds were destroyed under his direction, together with the name of the owner, lessee, or occupier of said tract of land or lot, and he shall deliver each such statement to the county assessor, and a certified copy thereof to the county clerk. He shall also issue vouchers for himself in inspecting weeds, at the rate of .... dollars per day, and to each laborer employed in destroying weeds at the rate of .... dollars per day, for the time actually employed. These vouchers shall be presented to and audited by the county clerk, who shall indorse thereon the amount he finds due, and then they shall be returned to the payee named therein, or his assigns, or legal representatives, and be paid by the county treasurer out of any moneys not otherwise appropriated, or they shall be receivable for county taxes within the county in which they were issued, to the amounts indorsed thereon by the clerk.

SEC. 10. The county assessor shall assess a special tax on each lot or parcel of land on which weeds have been destroyed by the officers, as above directed, the amount of expenses incurred for inspection and in the destruction of the weeds, as set forth in the verified expense statement received from the inspector. Said taxes shall be collected in the same manner and with like penalties as other county taxes are collected: *Provided, however,* That the owner, lessee, or occupier or any land or lot in respect to which any such expense statement has been issued, may deposit the amount payable thereon with the county treasurer, and in each such case it shall be the duty of the treasurer to receive the same and give notice of the payment to the assessor.

"The expenses of destroying weeds should be paid eventually by the land on which the weeds were destroyed. It would evidently be unjust to pay them from funds raised by the community, and such a method would create a temptation to have one's weeds pulled at the public expense. To assess persons with the costs, or to punish by fine or imprisonment, involves litigation and per-

sonal difficulties that often cause the law to be inoperative."

SEC. 11. The State Weed Commission shall have power to prepare and issue all necessary printed forms, notices, and instructions, tending to secure uniformity in employment of labor, statements of expenses, and the rendering of reports.

SEC. 12. Each road supervisor shall, in December of each year, mail to the State Botanist a report in the prescribed form, stating approximately the number of acres in his district on which weeds of each species mentioned in Schedule A were destroyed under his direction during the preceding part of the year, the total cost of destroying them, and the cost of inspecting the land in his district. The State Botanist shall present to the Governor on the first Monday in February in each year, a report of the proceedings of the commission, together with a statement of its expenses, and of the total expenses by counties of inspecting land and destroying the weeds thereon during the preceding year, and of the total number of acres in each county on which weeds have been destroyed as required by this act. And it shall be the duty of the Governor to submit said report to the State Legislature, if then in session, or within the first week of its next regular session.

"A report such as is here proposed will require comparatively little time in compilation, and will aid materially in deciding how much is being done under the law toward the eradication of weeds. It will afford data needed to determine approximately how much the benefits derived from enforcing the law exceed the cost."

SEC. 13. The wilful resistance to, or wrongful interference with any weed inspector or assistant, or laborer employed by any weed inspector, while in the performance of any of the duties in this act prescribed, is hereby declared a misdemeanor, punishable by fine not exceeding .... dollars, or imprisonment not exceeding .... days, or both, in the discretion of the county court, and the county courts are hereby given jurisdiction of all such offences.

SEC. 14. The words, "owner, lessee, or occupier," wherever used in this act, shall include corporations, companies, associations, or agents owning, holding, occupying, or responsible for the use or care of any lot or land within the limits of this State, and they shall be subject to all provisions of this act in the same manner and with like liabilities as any other owner, lessee, or other occupier of lands or lots, and service of notice upon any agent or officer of any such company, corporation, or association shall constitute service upon said company, corporation, or association.

SEC. 15. It shall be the duty of the road supervisor or other officer directly responsible for the care of public highways in each township or county in this State to destroy or cause to be destroyed all weeds mentioned in Schedule A on the highways within his district, at or before the times mentioned in said schedule, and in such manner as to effectually prevent the production of their seeds. He is hereby directed to warn out labor or to employ labor for this purpose in the same manner as for repairs to the highway, and for neglect or failure to perform this work he shall be subject to the same penalties as for the neglect or failure to perform duties pertaining to the repair of highways.

SEC. 16. The State Weed Commission shall prepare a plan for the eradication of weeds mentioned in Schedule A found growing on lands belonging to the State, and also on lands within the State, the title of which still remains in the Federal Government, and shall report the same to the Governor, to be by him transmitted to each branch of the Legislature during the first week of the next regular session of the Legislature.

SEC. 17. The State Botanist shall at least once in every two years visit each county in the State, and personally consult with the inspectors of said county in order that he may inform himself in reference to the status of the law as respects enforcement, and that he may intelligently and from personal knowledge bring before the commission at its next session the further needs of the State in such matters as are entrusted to said commission. His necessary expenses connected with such visitation, and with his attendance upon the biennial session of the commission, shall, upon presentation of a certified voucher, countersigned by the secretary of the commission, be paid by the State Treasurer in the same manner as are the other expenses of the commission.

The suggested bill seems to provide for all that is at present practicable, and if supported by a healthy public sentiment, will meet the necessities of the case. It has one feature that should commend it heartily, viz: its small demands upon the revenues of the State. It involves no expenditures on the part of the State except the necessary expenditures of the commission, which need not exceed a very few hundred dollars for each biennium. The expense of enforcing the law falls finally upon the negligent land owner or corporation, and no opportunity for annoying or expensive litigation seems to be opened up by this law.

OUR WEED LAWS AS AT PRESENT NOMINALLY IN FORCE.

For the information of those of our citizens who may receive this bulletin, a copy of our weed legislation as it now exists is given in full:

Be it enacted by the Legislature of the State of Wyoming:

SECTION 1. It shall be the duty of every person, company, association of persons, railway company, corporation and municipal or public corporation in this State to destroy or cause to be destroyed on all lands or premises owned, leased, occupied, controlled or used by such person, company, association or corporation, and upon all rights of way owned, used or occupied by either of them, the noxious weeds hereinafter mentioned, namely, the *Salsola kali tragus*, commonly known as the Russian thistle and the Canadian Thistle.

SEC. 2. Each county road supervisor, district road supervisor, and board of the county commissioners in this State is charged with the duty of notifying the owner or occupant of any lands or premises upon which any of the noxious weeds mentioned in Section 1 of this act exist, of the existence thereof on such lands or premises, and the board of the county commissioners of any county may designate any county or district officers within their county, or any suitable person or persons therein, to give such notice, which shall be in such form, of such substance and purport as shall give effectual notice of the existence of the noxious weed or weeds to owner or occupant of the land or premises on which the same exists, and such board may allow such reasonable compensation, not exceeding three dollars per day for each day necessarily and actually employed by such officer or person so designated in the performance of such duty.

SEC. 3. Any person, company, association of persons or corporation mentioned in Section 1 of this act, who shall fail or refuse to destroy or cause to be destroyed any of the noxious weeds mentioned in this act on any lands or premises owned, used, leased, occupied or controlled by such persons, association of persons or corporation, including rights of way used, occupied or controlled by them, or either of them, after knowledge of the existence of any such noxious weeds on such lands or premises, shall be guilty of a misdemeanor, and, upon conviction thereof, shall be fined in any sum not to exceed five dollars for each day that any such noxious weeds shall remain living on the lands or premises owned, used, occupied, leased or controlled by such person, association of persons or corporation after the knowledge of the existence thereof or of notice of the existence thereof. The notice of the existence of any of such noxious weeds may be such as is required to be given by this act, or any notice, either oral or written, given by any person to the owner or occupant of lands or premises upon which such noxious weed or weeds exist, of the existence of the same.

Approved February 26, A. D. 1895.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING,

BULLETIN NO. 32.

MARCH, 1897.

POTATOES.

BY THE AGRICULTURIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

Wyoming Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

President of the University of Wyoming.

FRANK PIERREPONT GRAVES, A. M., Ph. D.

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Wyoming University Experiment Grounds

CONTENTS.

PART II.

ACKNOWLEDGEMENTS.

Much of the information contained in this bulletin has been obtained from the reports and observations supplied by the superintendents of the several experiment farms, (see names on inside cover) who have carried out the experiments as planned by us. W. H. Fairfield has ably assisted in the work, having made the greater part of the computations and tables.

I am grateful to the above station workers, the members of the station staff and others who have kindly aided in the preparation of the bulletin and in reading proof. Mr. Herbert Myrick of the American Agriculturist kindly furnished the article on pages 38 to 41. He sent additional information in regard to the prize contest, which I regret to say, came to late for insertion.

B. C. BUFFUM.

POTATOES.

B. C. BUFFUM.

Potatoes succeed in all parts of Wyoming, and form one of our most important and valuable farm crops. They seem capable of adapting themselves to all our conditions of soil, climate and altitude. Good yields are obtained in sheltered places up to 9,000 feet above the sea, even where light frosts are frequent during the growing season. The phenomenon of sufficient cold to produce a fringe of ice along a stream and still leave uninjured as tender foliage as that of potatoes, has often been observed, but so far as I am aware has not been explained. It would seem that the radiation is sufficient to cool the already cold water below the freezing point, while foliage on higher ground is protected by warm layers of air and the heat absorbed during the day At altitudes above 7,000 feet potatoes will ordinarily produce fair crops without irrigation. Below 7,000 feet altitude it is generally not safe to plant any crop where it can not be irrigated, but where they have been properly cared for and watered we have never recorded the failure of a crop, excepting small local failures where the cause is generally apparent.

The importance of the potato crop and the fact that so little was known of its possibilities, especially in the southern part of the state, led the station officers to inaugurate special experiments with potatoes on each of the farms. The same varieties have been grown upon each of the farms, and varied experiments have been made. Growing them under different soil conditions and at different altitudes, green manuring, different amounts of seed per acre, and dif-

ferent methods of preparing and treating the seed and crop have been investigated, reports of which are given in the following pages. Results with potatoes are so variable that it is impossible to draw a conclusion which applies to every year and all conditions. In order to make our results as nearly average as possible and eliminate the more apparent sources of error, a comparatively large number of varieties were grown in connection with the soil work and green-manuring tests of the home station. Here fifty varieties were grown under each of the conditions of 1895 and 1896, and we believe the average of so many in each case gives more reliable data than where a single variety is grown. In those parts of the state where agriculture is new there is a demand for information with regard to the best varieties. On this account a variety test was inaugurated. As such a test for a single season gives no reliable results the varieties under consideration were to be grown three seasons before a report should be made. No attempt has been made to grow all the varieties of potatoes that could be obtained. Fifty standard sorts were chosen, and in part two of this bulletin is given a report of this three years' test at each of the stations. We believe the varieties which have succeeded best with us during the past three years will succeed better than those which gave the poorer yields, if good, reliable seed is obtained.

Soil Work With Potatoes.

FOLLOWING DIFFERENT CROPS, LARAMIE, 1895:—Table I gives the yield, average per cent marketable, and average weights of the twelve largest tubers of fifty varieties on four kinds of soil. The millet stubble was land sown to millet in 1894, the crop of millet was harvested August 27th, and yielded at the rate of three tons and thirty pound's of cured hay per acre, and 731.6 pounds of seed. The timothy and clover, fall-plowed, was practically fallow land in 1894. Both timothy and clover produced poor stands, and the ground was plowed the middle of August to kill the weeds. The wheat yielded 36¼ bushels in 1894. The potatoes on the millet land made the largest yield. All the land was treated alike so far as possible, only differing in the kind of previous crop, the time the previous crop occupied the land, and in the irrigation of these crops, except that the timothy and clover land was fall plowed. The millet only received a partial irrigation early in the season of 1894. The timothy, clover, and wheat were each irrigated three times, the last irrigation occurring July 17th. When the potatoes were planted all the ground was very dry and they were irrigated to bring them up. After this irrigation a long period of cold wet weather greatly retarded their growing. Under these circumstances the lack of water on the millet land in 1894 may have influenced the yield of potatoes in 1895. The differences between those on the timothy and red clover land are not so easily accounted for. There is no apparent reason for the yields on the clover land falling below the average yield for each variety on all the land planted. A comparison of these with the yields from wheat land would indicate that fallow land, fall-plowed, will produce much larger

yields of potatoes than land which has produced a large crop of wheat. One per cent of the potatoes on the millet ground was affected with scab, one-half of one per cent on the timothy land, and on the other ground a trace only of scab was present.

TABLE I.—*Potatoes on Different Soils, Laramie, 1895.*

FIFTY VARIETIES.	Millet stubble	Timothy, Fall plowed	Red Clover, Fall plowed	Wheat stubble	Total on the four divisions
Average yield, pounds	9899	9598	7982	5995	8906
Average per cent marketable	84.6	85.0	83.0	74.8	83.6
Average weight of largest twelve, in pounds.	4.6	4.8	4.2	5.6	5.6

POTATOES ON DIFFERENT SOILS, LANDER, 1893:—Eight varieties were grown on each of the two kinds of soil represented on the experiment farm. The soil and crops on the two plats were treated alike. Plat No. 1 is first bench land above the river. It is a deep red colluvial soil, containing little humus. Plat No. 2 was on the bottom next to the river, and differs from No. 1 in that it is a black soil, containing a large amount of vegetable mold.* The large differences in yields in the third column of the table show the effects of different soils in the same locality on a crop and the importance of selecting that most suitable to the crop to be grown. The average increase in yield of the eight varieties on Plat 2 amounts to 105 per cent.

TABLE II.—*Potatoes on Different Soils, Lander, 1893.*

VARIETY.	Yield per acre, Plat I.	Yield per acre, Plat II.	Increased yield on Plat II.
	lbs.	*lbs.*	*lbs.*
Beauty of Hebron	9678	23628	13950
Early Mayflower	15060	28842	13782
Early Puritan	12702	32340	19638
Empire State	15372	22698	7326
Late Puritan	18858	26742	7884
Pride of the West	5040	23322	18282
Snow Drop	14562	25500	10938
White Elephant	11808	27990	16182
Average	12885	26383	13498

*See Soil Analyses in Bulletin No. 6, May 1892.

SUB-SOILING FOR POTATOES.

An acre plat was selected upon each of the experiment farms and one-half of it sub-soiled in the spring of 1896. With the exception of the sub-soiling the whole plat was treated in the same way. So far as the conservation of soil moisture is concerned the benefits of sub-soiling are not usually so apparent until the second and third seasons. But the gains in potato yields were so marked on the sub-soiled land that they are reported here. The potatoes planted on the sub-soiled plat on the Laramie farm did not come up, because of wet, cold weather.

SUB-SOILING FOR POTATOES, SHERIDAN, 1896:—The land was plowed eight inches deep and sub-soiled twelve inches deep. The potatoes were planted May 12th at the rate of 700 lbs. per acre. Those on the part of the plat not sub-soiled were ripening at the time of frost, Sept. 19th, while those on the sub-soiled land were still green. One variety was grown, the results of which are given in Table III. Twenty-one per cent more potatoes were produced on the sub-soiled ground, and they were larger. This would bring an additional return amounting to about three times the expense of sub-soiling if only one-half cent per pound were received for the crop. In addition it is expected that the land sub-soiled will be in a much better condition the next year.

TABLE III.—*Sub-soiling Land for Potatoes, Sheridan, 1896.*

VARIETY.	Yield on land subsoiled.	Weight of largest 12, subsoiled.	Yield on land not subsoiled.	Weight of largest 12, not subsoiled.	Gain in yield, subsoiled.
	lbs.	*lbs.*	*lbs.*	*lbs.*	*Per cent.*
Koshkonong................	12860	6.5	10620	6	21

SUB-SOILING FOR POTATOES, SUNDANCE, 1896:—Table IV gives the results with seventeen varieties at Sundance. They were planted May 8th, at the rate of 680 lbs. of seed per acre. One variety, the Polaris, gave a larger

yield on land not sub-soiled, the deficiency amounting to ten and five tenths per cent, indicated in the table by a minus sign. Late Puritan gave the same yield on both kinds of ground, while the Rural Blush gave one hundred and thirty-seven per cent more on sub-soiled land. The average gain for seventeen varieties is eighteen and one-half per cent, which would much more than pay the expense of sub-soiling, even at the low price of one-half cent per pound for the crop.

TABLE IV.—*Sub-soiling Land for Potatoes, Sundance, 1896.*

VARIETY.	Yield on land subsoiled.	Yield on land not subsoiled.	Per cent gain due to subsoiling.
	lbs.	*lbs.*	
Arizona	11480	9240	24.0
Bill Nye	10080	8120	24.0
Boston Red	10780	9520	13.0
Clark's No. 1	7840	7700	2.0
Delaware	10500	8120	29.0
Early Norther	11340	10080	12.5
Late Puritan	4340	4340	0
Morning Star	12320	9660	27.5
Pearl of Savoy	9100	7140	27.5
Polaris	7140	7980	—10.5
Pride of the West	8540	6440	32.6
Rural Blush	5320	2240	137.5
St. Patrick	7000	5740	22.0
Vanguard	5740	5180	10.8
White Elephant	10080	8400	20.0
White Star	7560	7140	5.8
World's Fair	5320	4900	8.5
Average	8499	7173	18.5

SUB-SOILING FOR POTATOES, WHEATLAND, 1896:—The potatoes were planted May 11th at the rate of 680 lbs. per acre. No difference was noticed in the time of bloom or the time of maturity between sub-soiled land and that not sub-soiled. They came into bloom July 29th, and were ripe October 10th, maturing in one hundred and twenty-two days. One variety was planted. The results are given in Table V. Larger potatoes were produced on the land sub-soiled, the gain on subsoiled ground of marketable potatoes amounting to 18¼ per cent, which with the yields obtained and the market price of 50 cents per hundred would hardly pay the expense of subsoiling the first year.

TABLE V.—*Subsoiling Land for Potatoes, Wheatland, 1896.*

VARIETY.	SUBSOILED.				NOT SUBSOILED.				Per cent gain in yield on subsoiled land.
	Total yield per acre.	Yield per acre marketable.	Per cent marketable.	Weight of largest 12	Total yield per acre.	Yield per acre marketable.	Per cent marketable.	Weight of largest 12.	
	lbs.	*lbs.*		*lbs.*	*lbs.*	*lbs.*		*lbs.*	
Triumph...	3160	1984	62.8	13	2560	1760	68.8	10.2	18.4

FERTILIZERS FOR POTATOES.

The question of fertilizers for potatoes in this state is not a difficult one to meet. Analysis of our soils show that they contain comparatively large quantities of the essential mineral plant foods. (See Bulletin No. 6, 1892.) Our upland soils are deficient in vegetable molds or humus, which contains nitrogen. This deficiency can be remedied by green manuring, especially with alfalfa, peas, or other leguminous crops, or by applying stable manure. It has been shown in other places that the addition of potash fertilizers, such as kainit, even where large quantities of potash are already found in the soil, will greatly increase the yield of potatoes. We are unable to report such an experiment at this time. However, good crops of potatoes can be raised upon many of our virgin soils, and we do not recommend that our farmers go to the expense of purchasing commercial fertilizers for this crop. The value of vegetable mold in a soil is indicated somewhat by Table II on page 6, where the yield on bottom lands containing humus was over one hundred per cent higher than the yield obtained on upland soil.

FERTILIZING WITH BONE-MEAL, LARAMIE, 1895: —Three varieties were planted with bone meal, using at the rate of one thousand pounds of bone meal per acre. The potatoes were dropped into the furrow, and the bone meal spread along over them before covering. They were planted on the same soils as those reported in the first part of this

bulletin. (See Table I.) In the variety test these varieties were planted on the same kind of land, but the seed was treated for scab with corrosive sublimate. With the exception of these three varieties planted with bone-meal, few of the potatoes planted without first treating the seed came up, as the seed rotted in the ground on account of cold weather and too much water. On this account those planted with bone meal and not treated with corrosive sublimate are not comparable with the same varieties without bone meal, the seed of which was treated. The fact is of interest, however, that planting untreated seed with bone-meal secured a stand and small yield, while all other untreated seed planted without bone-meal failed to grow. Table VI is given to show the effect of bone-meal compared with seed of other varieties not treated, most of which rotted in the ground, and with the same varieties, the seed of which was treated with corrosive sublimate. The yields given are marketable potatoes in sacks of 100 lbs. each. "Per cent m." means the per cent of the crop which was fit for market. The corrosive sublimate effectually prevented wet rot of the seed. The principal effect of the bone meal seemed to be to prevent enough of the seed from rotting in the ground to secure a partial stand.

TABLE VI.—*Potatoes with Bone-Meal, Laramie, 1895.*

		MILLET GROUND		TIMOTHY GROUND		CLOVER GROUND		WHEAT GROUND		AVERAGE.	
		Yield in cwt.	Per cent m.	Yield in cwt.	Per cent m.	Yield in cwt.	Per cent m.	Yield in cwt.	Per cent m.	Yield in cwt.	Per cent m.
Alexander Prolific	Without treatment	None	ca	me	up.						
	Bone meal........	57	87	44	77	39	75	65	90	48	81
	Treated for scab...	117	91	107	85	126	92	112	92	116	89
Chas Downing	Without treatment	None	ca	me	up.						
	Bone meal........	61	91	25	92	34	86	18	77	38	89
	Treated for scab ..	132	88	118	83	107	85	94	79	117	85
Koshkonong	Without treatment	None	ca	me	up.						
	Bone meal........	80	92	82	81	57	92	77	92	74	88
	Treated for scab ..	118	89	141	95	100	85	85	84	117	91

GREEN-MANURING FOR POTATOES, LARAMIE, 1896:—In 1895 an acre plat was planted with millet, field peas, and spring rye. The millet produced no crop, and the ground it occupied was practically fallow, as the weeds more than equalled the millet and the soil remained nearly bare. The peas produced a good heavy crop. They were plowed under eight or nine inches on Aug. 13, when the peas in the pod were green and small. A few peas which were allowed to ripen at one end of the plat yielded at the rate of 13.4 bushels of dried peas per acre. The rye was plowed nine inches deep on July 16th, when fully headed. The straw was heavy, and not all of it was fully covered. The rye yielded at the rate of 2,785 lbs. dried straw and grain per acre. Fifty varieties of potatoes were grown on each kind of ground. The average yield, per cent marketable, and weight of largest twelve tubers is given in Table VII. Comparing the rye and peas plowed under with the millet ground, which was practically without a crop, with potatoes at one cent per pound, it gives the peas a value of $31 per acre, and rye a value of $19 per acre as a green manure for potatoes.

TABLE VII.—*Green-Manuring for Potatoes, Laramie, 1896.*

AVERAGE OF FIFTY VARIETIES.	Millet plowed under.	Peas plowed under.	Rye plowed under.	Total.
Yield per acre in pounds marketable potatoes	8044	11129	9949	9411
Per cent marketable	87.3	90.3	91.1	88.9
Average weight of largest 12 in pounds	5.7	6.5	5.8	7.3

Insect Enemies and Diseases of Potatoes.

INSECTS.

THE COLORADO POTATO BEETLE (*Doryphora decemlineata*) causes some damage at the lower altitudes in our state, where they must be kept in check. The poison which is generally used to kill the beetles is Paris green.* It may be applied dry by being thoroughly mixed with air-slacked lime, land plaster, or flour and sifted on the vines. One pound of the Paris green to fifty or seventy-five of the diluent is as strong as it should be applied. The best time to sprinkle the vines with the dry powder is early in the morning when there is no wind and when the vines are damp with dew, or just after a light shower.

The most satisfactory method of applying Paris green is mixing it with water, one pound of poison to two hundred gallons of water. Keep the solution mixed, as the Paris green is heavy and settles to the bottom. It should be applied to the vines in a fine spray. There are many appliances on the market for doing this. I have seen very good work done with a whisk broom by dipping it into the liquid and sprinkling the vines with a quick shaking movement. Still better work can be done with a cheap syringe made for the purpose, while, of course, the most effective and convenient method, where large areas are to be treated, is to use some of the more modern spraying pumps which keep the liquid well mixed and with which two or more rows can be sprayed at once. The same method will be effectual in destroying the

*See Bulletin No. 7, July 1892, on "Insecticides."

black blister beetle which has been reported as working on potatoes in this state.

The potato beetle has never been injurious on the Laramie plains, and so far as I know only occasional adult beetles have been observed. In six years I have not seen more than a dozen specimens here, and never in the larva state. Other plants than the potato, as the wild tomato, on which the beetles sometimes live, are abundant on the Laramie plains, but our conditions, fortunately, do not seem favorable to the multiplication of the pest.

UTAH CRICKET.—At Lander the "Utah" or "Salt Lake" crickets* were quite destructive to the potato tops in 1894. The only methods of combating them successfully seem to be the ones that are generally used for destroying grasshoppers. Last season they were not reported as destructive.

POTATO MAGGOT.—The larva of a small fly† has done some damage to the tubers before they are dug, on the Laramie Farm. They have rapidly increased during the past two seasons. These larva are about one-half inch long and occur in great numbers in the soil. They eat the living tubers. Sometimes potatoes are found two-thirds of which have been consumed, the opening made being completely filled with the maggots. Should they continue to increase it will be necessary to determine some method of checking their ravages. The flies come out early in the spring, during April and May. When plowing the ground great numbers of them are found burrowing in the soil. The larva pupate late in the fall and it is probable that deep plowing as late as it could be done would greatly reduce their numbers by bringing them near the surface where the dry, cold weather would be fatal to them.

*This is a new species not yet named.

†The name of this fly has not yet been determined for lack of examination and study, but it appears to belong to the family *Bibionidae*.

POTATO SCAB.*

This disease is found wherever potatoes are grown, and we regret to state that many of our potato growers are indifferent in regard to it until the disease becomes so abundant as to practically destroy their crop. Our best farmers will not allow potato scab to be introduced into their soils if they can prevent it. Scab is produced by a fungus plant growing on the potatoes. This fungus grows from spores, and unless these spores are placed in the ground by planting infected seed, no scabby potatoes will be produced. If the seed potatoes show any scab they should be treated to kill all the spores before the seed is planted. If a piece of land has produced scabby potatoes the season before, or even two seasons before, it is better to plant to some other crop, as the scab is apt to remain in the ground several years. The treatment is very simple. It consists of immersing the seed potatoes, before they are cut, in a solution of fifteen gallons of water and two ounces corrosive sublimate, for one and one-half hours. When they are dry, cut and plant. Use only *wooden* barrels to contain the solution. Do not use the barrels which have held the solution or the sacks in which the treated potatoes have been placed for anything else, as corrosive sublimate is a deadly poison.

TREATING POTATOES FOR SCAB, LANDER, 1894. —It appears from this experiment that treating for scab may sometimes be detrimental to the crop. Twelve varieties were planted in rows side by side. One row of each variety was planted with seed which had been treated by dipping into a solution of corrosive sublimate and one row planted with seed not treated. Only one variety gave a larger yield from the treated seed.

The superintendent, Mr. Meyer, reported that there was a little scab on nearly all the seed planted, but there was no scab to speak of on the potatoes raised from either the treat-

*See Bulletin No. 21, January 1895, "The Grain Smuts and Potato Scab."

ed or untreated seed. The potatoes treated took longer to come up and did not seem to do as well at any time through the season as those not treated. Table VIII gives the results. The average yield of the twelve varieties was 118 bushels per acre from treated seed and 172 bushels per acre from the seed not treated. It is likely that something in the treatment of the seed produced these results. Any one of several circumstances may have caused the trouble. If the seed potatoes were left too long in the solution, or the solution was too strong, of if the potatoes were kept too long after treatment before they were planted their vitality might have been so reduced as to injure the crop.

TABLE VIII.—*Treating for Scab, Lander, 1894.*

VARIETY.	YIELD PER ACRE.		Weight of largest 12.
	Seed treated.	Seed not treated.	
	lbs.	*lbs.*	*lbs.*
Early Rose	7572	7740	7.5
Early Mayflower	12030	16878	7.5
Early Puritan	6120	8580	7.5
White Elephant	10602	13212	11.0
Snow Drop	3462	8340	7.5
Empire State	6702	11964	8.0
Bill Nye	10134	11232	7.5
Late Puritan	5502	9138	8.0
Beauty of Hebron	6204	13398	8.5
Triumph	5358	9132	8.5
Jumbo	7320	11220	10.0
Vanguard	3942	2760	7.5

TREATING FOR SCAB, LARAMIE, 1895.—This experiment shows quite a different effect of treating the seed with corrosive sublimate than that obtained upon the substation at Lander. Table IX gives the comparative results of treating the seed of nine varieties. The most noticeable effect of this treatment was to prevent the seed rotting in the ground during the cold, wet weather which followed planting. Seed-potatoes of fifty varieties were treated, all of which came up well and produced good yields. Of the nine varieties planted without treating the seed, only the White Elephant made a good stand and reference to the table will

show that this variety gave a larger yield and less scab from the treated seed. The per cent of scab was computed from all the potatoes produced whether there were enough growing to warrant computing the yields or not. The number of potatoes which were affected with scab divided by the total number of tubers gave the percent scab given in the table. There was not enough scab on any of the potatoes from treated seed to hurt them commercially while many of the potatoes from untreated seed were so badly affected as to make them unfit for market. In this experiment the seed potatoes were treated by placing them in a solution of corrosive sublimate made by dissolving two ounces of the poison in 15 gallons of water. They were left in the solution for one and one-half hours, after which they were spread out to dry and cut the same day they were treated. The seed potatoes not treated were also cut at the same time and both treated and untreated tubers were planted the day after they were cut. Attention is called to the fact that the difference in yields between treated and untreated seed is due mainly to the difference in the amount of the seed that grew, while difference in the amount of scab must be due to treatment.

TABLE IX.—*Treating for Scab, Laramie, 1895.*

VARIETY.	SEED TREATED.			SEED NOT TREATED.		
	Yield.	Per cent market-able.	Per cent scab.	Yield.	Per cent market-able.	Per cent scab.
	lbs.			*lbs.*		
Burpee's Superior	10520	88	2	......	......	51
Clark's No. 1	10735	79	Trace	......	......	22
Early Norther	9615	85	Trace	......	......	32
Monroe's Seedling	9765	85	Trace	4320	85	28
Reed's No. 86	6795	78	None	2445	85	4
Rose Seedling	7440	90	Trace	2197	96	8
Vanguard	7275	84	7	None	came	up.
White Elephant	7207	82	Trace	6810	82	4
World's Fair	8077	88	None	None	came	up.

POTATO BLIGHT.

We are unable to offer positive evidence that true potato blight has caused injury to the potato crop in Wyoming. The superintendents of the experiment farms have believed their potatoes were more or less damaged by the blight but I have not observed any fields affected with the fungus known to produce this disease.*

Other causes may make the vines appear to be affected with blight, but if it is certain that the blight is causing the injury, experience in other places indicates that some benefit may be derived from spraying the vines with Bordeaux mixture.

Methods of Preparing Seed Potatoes.

Much might be said concerning the selection as well as the preparation of potatoes for planting. A favorable climate and soil, together with the selection of the best potatoes for seed, should continually improve a variety. In some places, however, potatoes "run out." By "running out" it is meant that the tubers so deteriorate in size, shape, smoothness and quality as to decrease the value of the crop. Where the tubers run out badly, it may be necessary to obtain seed from some other locality every year or at least every few years to keep up a high standard of excellence in the crop. It is never profitable to plant poor seed, and this is especially true with potatoes where the seed is poor from deterioration of the crop under the same conditions.

Generally speaking the potatoes we have grown upon the experiment farms have not shown a tendency to run out, at least to any noticeable degree. There seems to be

*For the nature of these fungi see Bulletin No. 21 of this Station.

considerable difference in varieties in this respect. Under the same plan of selecting the seed some few varieties have deteriorated, while others, and I think the majority of them, have improved. Only one variety has continually produced poorer potatoes than the seed planted. This is the Empire State. The tubers show a tendency to elongate and become pointed at the stem end, which injures their shape for market. In those parts of the state where our experiments have been conducted, most varieties can be grown year after year in the same place without the necessity of renewal by obtaining seed potatoes from some other locality. In fact, using the small potatoes from the preceding crop for seed is often resorted to without the casual observer noting any difference in the resulting crop. That poorer potatoes are actually produced than would be the case if the best tubers were selected for seed will be shown later. There is no doubt that "blood tells" with potatoes as well as with other plants or with animals and the proper way to work up the seed of a variety of potatoes to produce the finest crops is to select always the very best in size, shape and general quality for the mother potato. The fact that good crops have been produced for several years by planting potatoes which were too small for market has led many to believe in the practice. That better crops are actually produced where better potatoes are selected for seed is shown in our experiments in planting whole and cut seed. In each case the potatoes planted whole were small tubers, while those cut were large. In no instance has the crop from the cut seed been as large as that produced from the small potatoes planted whole. This is no doubt due to the greater vitality of the whole potatoes, together with their ability to withstand too dry or too wet weather because better protected by their skin covering. However, in no case was there so large a per cent of the crop fit for market from the small tubers planted whole as there was from the large potatoes cut before planting. At Laramie in 1896, 79.3 percent of the crop

from small tubers of Rural Blush was marketable, while 86.3 percent of the crop from large potatoes was marketable. Of the Early Rose crop, small tubers planted whole produced 83.4 percent marketable potatoes, while large tubers cut produced 93.4 per cent marketable. At Wheatland in 1893 three percent less of the total yield was fit for market of the crop from small potatoes planted whole. At Lander in 1894 about one percent less of the total crop was marketable from the small potatoes.

If such deterioration takes place the first year small potatoes are planted, it is probable the difference would be much greater if the practice of planting small potatoes raised from small potatoes were carried out. However if these small potatoes have been produced from planting good seed there is no question that larger crops may be obtained for a season or two by planting them whole.

WHOLE VS. CUT SEED, LANDER, 1894:—In Table X. the crop produced from twenty pounds of small potatoes planted whole is compared with the average crop from seven different methods of cutting the seed, the same amount being planted in each case.* The yield in the table is the number of pounds produced from twenty pounds of seed. About one percent less of the total yield was marketable from the whole seed, but the gain in yield of marketable potatoes from whole seed is twenty-seven and one-half percent.

TABLE X.—*Whole vs. Cut Seed, Lander, 1894.*

VARIETY.	WHOLE SEED, 20 LBS. Total yield.	WHOLE SEED, 20 LBS. Yield marketable.	WHOLE SEED, 20 LBS. Per cent marketable.	CUT SEED, 20 LBS. Total yield.	CUT SEED, 20 LBS. Yield marketable.	CUT SEED, 20 LBS. Per cent marketable.	Gain with whole seed, per cent.
	lbs.	*lbs.*		*lbs.*	*lbs.*		
Pride of the West	310	278	89.7	241	218	90.4	27.5

*The different ways of cutting the seed here referred to are compared in this report under the heading "Different Ways of Cutting Seed, Lander, 1894," which see.

WHOLE VS. CUT SEED, LARAMIE, 1895.—Seed of the Rose Seedling potato was selected and prepared in five different ways. One hundred and thirteen small potatoes amounting to nine pounds and three ounces were planted whole, and the same weight of larger potatoes was cut in each of the following ways: Cut in half lengthwise; cut two eyes to each piece; cut one eye to each piece; and lastly pared comparatively deep, the parings with one eye on each piece planted. As before stated but little of the seed planted in 1895 without first being treated, came up. In this experiment 96 percent of the potatoes planted whole came up, 40 percent of those cut in half lengthwise, 5 percent of those cut two eyes to the piece, and less than one percent of those cut one eye to the piece or planted as parings. On account of the small number of plants occupying the land the experiment was abandoned after determining the percent of each which grew.

WHOLE VS. CUT SEED, LARAMIE, 1896.—The great difference in the yields here (see Table XI.) evidently is due to planting the potatoes in ground that was too dry. The dry soil coming in contact with the cut seed drew out the moisture and the most of it failed to grow. The vitality of the cut seed which did grow was so reduced that the vines were not as large or thrifty throughout the season as were those from the whole potatoes.

TABLE XI.—*Whole vs. Cut Seed, Laramie, 1896.*

VARIETY.	WHOLE SEED.			CUT SEED.		
	Total yield.	Yield marketable.	Per cent marketable.	Total yield.	Yield marketable.	Per cent marketable.
	lbs.	*lbs.*		*lbs.*	*lbs.*	
Early Rose	14230	11867	83.4	3108	2903	93.4
Rural Blush	10824	8583	79.3	5877	5077	86.3

WHOLE VS. CUT SEED, SHERIDAN, 1894.—In Table XII. are given the yields of ten different varieties from whole and cut seed with the increase in yield from the whole potatoes. No notes of the amounts of seed planted or of the percent of the crop which was marketable are available. The yields here are given in sacks of one hundred pounds each. White Elephant gave a larger yield from cut seed but the average increase in the crop from the whole seed is ten percent.

TABLE XII.—*Whole vs. Cut Seed, Sheridan, 1894.*

VARIETY.	Whole. yield per acre.	Cut. yield per acre.	Gain in yield with whole seed.
	cwt.	*cwt.*	*per cent.*
Vanguard	131.9	118.9	11
Empire State	156.6	145.0	8
Iron Clad	156.6	139.2	12
Bill Nye	136.3	117.4	16
White Elephant	113.1	116.0	−3
Early Rose	137.7	131.9	4
Hotel Favorite	160.9	150.8	6
Beauty of Hebron	155.1	145.0	7
Marquette	162.4	129.0	26
Snow Drop	145.0	130.4	11
Average	145.6	132.4	10

WHOLE VS. CUT SEED, WHEATLAND, 1893.—This experiment, which is reported in Table XIII, presents the most complete and valuable data at hand on this subject. The difference in the amount of seed per acre with cut and whole seed is not great and as the hills were planted about the same distances apart the difference in weight merely indicates the difference in the size of the pieces planted. Practically all the whole potatoes planted, grew. The last column in the table gives the percent of the cut seed which failed to grow. This enables the reader to make comparisons between the whole and cut seed where all of both came up. The whole seed was selected from the small potatoes not fit for market while the cut seed was of average sized

tubers cut two eyes to each piece. Thirteen and six-tenths percent more potatoes were produced from the whole seed.

TABLE XIII.—*Planting Whole Potatoes vs. Cut Seed, Wheatland, 1893.*

VARIETY.	WHOLE SEED.				CUT SEED.				
	Seed per acre	Yield per acre.	Per cent fit for market.	Weight of largest 12.	Seed per acre.	Yield per acre	Per cent fit for market.	Weight of largest 12.	Per cent which failed to grow.
	lbs.	*lbs.*		*lbs.*	*lbs*	*lbs.*		*lbs.*	
Beauty of Hebron	760	6250	60	6.5	494	4664	75	7.0	0
Bill Nye	836	8170	70	8.0	492	7220	80	8.2	10
Early Mayflower	643	7220	75	7.0	570	4550	60	7.1	40
Early Ohio	684	5320	80	7.5	532	2432	75	8.1	75
Early Puritan	608	7446	75	7.3	570	4370	75	7.0	40
Early Rose	722	7220	75	9.2	608	2470	80	8.3	85
Empire State	874	8938	75	8.0	532	4484	75	8.5	25
Gov Rusk	760	8664	80	11.0	455	7600	80	11.5	0
Hoffman	608	7980	80	13.0	455	64.0	85	13.1	10
Jumbo	675	8816	80	13.6	532	7000	80	13.0	0
Late Puritan	836	7980	70	7.5	494	5016	80	8.0	25
Mammoth Pearl	798	11400	80	14.0	722	8550	80	14.5	10
New Burbank	798	8240	70	8.1	380	6460	75	8.0	20
Pride of the West	988	7236	60	8.0	608	6250	75	8.2	0
Rose Seedling	874	10496	80	12.6	532	6250	80	13.1	25
Snow Drop	445	6840	50	6.0	418	6650	65	7.0	0
Triumph	453	6080	60	7.6	456	4750	65	8.0	10
Vanguard	798	9500	85	15.1	418	8626	85	16.0	0
White Elephant	608	8258	85	12.6	532	7600	80	11.5	0
Average	725	7932	73	9.6	516	5863	76	9.8	

WHOLE VS. CUT SEED, WHEATLAND, 1894.—Table XIV. gives the amounts of seed per acre and the yields with whole and cut seed and the percent of gain in yield with whole seed. The reason for the great difference in yields between the whole and cut seed is indicated by the weather conditions at the time of planting the seed. The potatoes were planted May 7 when the ground was very loose and dry. They were irrigated on May 30 to bring them up, but the most of them did not come up tlil the middle of June. Under such conditions the whole seed would retain its vitality and produce much better stands than seed which had been cut.

TABLE XIV.—*Whole vs. Cut Seed, Wheatland, 1894.*

VARIETY.	WHOLE SEED.		CUT SEED.		Gain in yield with whole seed.
	Seed per acre.	Yield per acre.	Seed per acre.	Yield per acre.	
	lbs.	*lbs.*	*lbs.*	*lbs.*	*per cent.*
Early Rose	1562	13376	670	7600	76
Early Ohio	2090	10636	508	2606	308
Early Mayflower	1240	12814	556	10636	20
Early Puritan	1330	13034	532	8702	50
Hoffman	874	10954	508	6118	79
White Elephant	684	26604	570	7486	256
Snow Drop	760	9766	484	5016	95
Rose Seedling	786	8908	556	4864	83
Empire State	824	10300	514	5358	92
Gov. Rusk	760	12436	456	7420	68
Bill Nye	714	11666	514	4864	140
Late Puritan	950	10070	514	6510	55
Pride of the West	950	8132	608	4864	65
Beauty of Hebron	760	8246	456	7334	12
Triumph	1140	10260	684	5340	92
Jumbo	1064	12274	646	5510	122
Mammoth Pearl	928	15200	570	7600	100
Vanguard	874	12388	474	6300	97
New Burbank	914	7980	570	5472	46
Average	1011	11844	547	6295	88

Some experiments were made upon the home station to see if some such substance as land plaster would not keep the potatoes from drying out by rolling them in it after they were cut, but no results of value were obtained. Under our conditions planting whole seed seems to insure a stand and crop where cut seed will dry out and fail.

DIFFERENT METHODS OF CUTTING SEED POTATOES, LANDER, 1894.—The test reported in Table XV. was made to determine which of the eight methods of cutting the seed would produce the largest amount of marketable potatoes. The total yield given is the number of pounds produced from twenty pounds of seed of Pride of the West potatoes. No. 1, cutting the potatoes in quarters lengthwise leaving one-fourth of the seed end on each quarter, gave the best results, and No. 8, in which the seed was also quartered, gave the second best result. Cutting one eye to each piece, first cutting off the seed end, gave a better result than when the seed end was left on, which would neces-

sitate cutting much smaller pieces. When cut in larger pieces better results were obtained when the seed ends were left on.

TABLE XV.—*Methods of Cutting Seed Potatoes, Lander, 1894.*

TREATMENT.	Total yield.	Large.	Small.
	lbs.	*lbs.*	*lbs.*
No. 1—Cut in quarters lengthwise of tubers, leaving seed ends on	335	308	27
No. 2—Cut same as No. 1. Treated with corrosive sublimate. There was no scab on potatoes from treated or untreated seed, and the treatment seemed detrimental	305	285	20
No. 3—Small potatoes left whole	310	278	32
No. 4—Cut one eye to a piece. Seed end cut off.	244	222	22
No. 5—Cut as nearly as possible one eye to a piece and seed end left on	210	190	20
No. 6—Cut in halves lengthwise of tuber. Largest tubers not used.....	174	151	23
No. 7—Cut in halves lengthwise of tuber. Seed ends cut off. Largest tubers not used	102	84	18
No. 8—Cut in halves lengthwise and each half cut in two crosswise, leaving seed ends on	321	289	32

Cutting the potatoes in quarters lengthwise so as to leave one-fourth of the seed end on each quarter has been practiced at the home station for the past three years and where the seed potatoes are not too large this method of cutting is recommended.

SEEDING AT DIFFERENT RATES PER ACRE, LANDER, 1895.—The number of pounds of seed potatoes used is not given accurately. The records state that seed cut two eyes to the piece and planted sixteen inches apart in the row, amounted to between five and six hundred pounds per acre. Then those cut the same and planted eight inches apart would equal twice this amount. Those cut two eyes to each piece and planted four inches apart would use as much as a ton of seed per acre, and cut one eye to each piece and planted four inches apart about one-half ton per acre. The amount of seed potatoes per acre will depend upon the size of the pieces and the distance the hills are apart. The usual seeding is from four hundred to six hundred pounds per acre, at least where machines are used that drop the seed fifteen to eighteen inches apart in rows three or more feet apart. We believe it pays to use

more seed and plant closer than this. Rows two and one-half to three feet apart allow room for sufficent cultivation, and planting so that hills will stand eight inches apart in the row does not seem to overcrowd the plants, with most varieties. In Table XVI. the seed cut two eyes to each piece, and planted eight inches apart, using about a thousand pounds per acre, gave the best result.

TABLE XVI.—*Cutting Seed Differently and Different Rates per Acre, Lander, 1895.*

VARIETY.	Method of cutting.	Distance apart in rows.	Yield per acre.	Weight of largest twelve.
		inches.	*lbs.*	*lbs.*
Empire State	2 eyes	16	11637	11.5
	2 eyes	8	13524	10.0
	2 eyes	4	13192	7.5
	1 eye	4	5049	7.0

SEEDING AT DIFFERENT RATES PER ACRE, WHEATLAND, 1895.—Table XVII. The potatoes were cut two eyes to each piece and planted May 14th. The land was prepared the year before by plowing under a heavy crop of green alfalfa, so that the soil was in excellent condition. However, the yields obtained were unusually small. As all were treated alike the results are comparable, and show the effects of different rates of seeding. In each case that amount of seed which produced hills eight inches apart in the rows gave the largest yields of marketable potatoes. Where planted as closely as four inches apart, the vines were evidently too crowded, as shown by the resulting small percent of tubers that were fit for market. The seed was planted eight inches apart in the rows upon that famous prize acre of potatoes in the northern part of this state, where in competition for the largest yield over 974 bushels were grown on a single acre. (See account on page 38.)

TABLE XVII.—*Different Seeding per Acre, Wheatland, 1895.*

VARIETY.	Amount seed per acre.	Distance apart of hills in row.	Total yield per acre.	Yield marketable potatoes per acre.	Per cent of potatoes marketable.	Weight of largest twelve.
	lbs.	*inches.*	*lbs.*	*lbs.*		*lbs.*
Mammoth Pearl	520	17	4400	3432	78	12.6
	736	8	6890	5443	79	12.0
	910	4	5200	2730	52	8.7
Rose Seedling	487	18	3900	3042	78	16.0
	673	8	7375	5605	76	12.5
	840	4	7575	4166	55	10.0

Upon the home station at Laramie the varieties (see part II of this Bulletin) were planted at the rate of 700 to 1,000 pounds per acre. With average sized tubers cut into quarters lengthweis this amount of seed planted the pieces eight inches to twelve inches apart in the row. Our comparatively large yields in 1894 at Laramie is explained by the fact that the rows were only two feet apart, more potatoes being produced on the same amount of land than when the rows are two and one-half or three feet apart. Rows two feet apart are too close, as even at high altitudes the plants grow so large that it is difficult to cultivate without injury to them. In general, early, small topped varieties may be planted closer together than later and larger topped kinds and in localities where the tops grow large it will be necessary to give them more room.

Potatoes at Different Altitudes.

As the conditions vary so materially at the several experiment farms it is not easy to ascertain what differences in the crop are due to difference in altitude. The home station on the Laramie Plains is over 3,000 feet above the substation at Sheridan, but Sheridan being farther north tends to equalize the temperature. so the greatest differences in climate are in atmospheric pressure and the range of temperature. The nights are generally cool in all parts of the state and the greater heat during the day at the lower places makes the daily range of temperature less at the higher altitudes. Below is given a comparison of the potato seasons at the different altitudes with the mean annual temperature at each place. The dates given are taken from the reports of potato experiments at each place and are not infallible. Planting early potatoes for an early crop might be done before the dates given, while planting for

TABLE XVIII.—*Comparative Seasons and Altitudes.*

	Time of Planting.	Time of Harvest.	Time of First Killing Frost.	Mean annual temperature.
Laramie, 7200 feet.	May 10 to June 1	Sept. 20 to Oct. 20	Sept. 1 to Sept. 10	40.1
Saratoga, 6000 feet.	May 10 to June 1	Sept. 15 to Oct 1	Sept 1 to Sept. 20	40.4
Lander, 5500 feet........	May 1 to May 15	Oct. 1 to Oct. 15	Sept. 10 to Sept. 20	43.7
Wheatland, 5000 feet	May 1 to May 15	Sept. 15 to Oct. 1	Oct. 1 to Oct. 15	49.0*
Sundance, 4500 feet......	April 15 to May 20	Sept. 20 to Oct 10	Sept. 10 to Sept. 20	41.2
Sheridan, 4000 feet	May 1 to May 15	Oct. 1 to Oct. 15	Sept. 10 to Sept. 25	41.5

*Average of two years only.

late shippers might be done after the date indicated. In the column giving the time of first killing frosts the time given only indicates that killing frost may be expected between

these dates. It may come earlier or later. For instance, at Laramie killing frost occurred twice before September 1, and one year it did not come till September 23.

The time between planting and harvesting the crop is almost identical at each place. Early varieties ripen and the tops die down before time of frost, but the tops of the late varieties usually remain green until killed by frost. As a rule, a few varieties have not fully ripened their tubers at Laramie, though all have been sufficiently ripe to keep well through the winter.

YIELDS UPON THE EXPERIMENT FARMS.—Our observations have led us to believe that differences in yields are principally due to favorable or unfavorable soil conditions, and treatment of the crop. We have not been able to show that variations in yield correspond in any way with variations in altitude. However, under this head we publish Table XIX, which gives the yields with average for each place. This table indicates the comparative crops that have been produced in the different sections of the state, and I think a fair estimate of

TABLE XIX.—*Comparative Potato Yields.*

	Yield 1894	Yield 1895.	Yield 1896.	Yield, average
Laramie, 7200 feet altitude	13913	10652	10574	11713
Lander, 5500 feet altitude	8663	10082	30164	16303
Wheatland, 5000 feet altitude	9043	6240	5296	6860
Sundance, 4500 feet altitude		7006	6455	6730*
Sheridan, 4000 feet altitude	15138	13025	8271	12145
Average for the Stations				10750

*Average of two years

the average potato yield for the state may be taken from it. The table shows the average total yields of potatoes at the five places considered, to be 107 sacks of 100 pounds each, or about 179 bushels per acre. Taking the percent of the total crop which has been marketable in these experiments the average yield of marketable potatoes is about 150

bushels per acre. The average yield of potatoes for the United States is placed at about 100 bushels per acre. (See the Year Book of the Department of Agriculture for 1895.) The same report gives the average yield in Wyoming for the same year 100 bushels per acre.

SPECIFIC GRAVITIES AT LARAMIE AND SUNDANCE.—That there are some differences in potatoes grown at high and low altitudes which are due to the difference in altitude and the consequent climatic conditions is probable. In order to obtain some idea of the quality of potatoes grown at different altitudes the specific gravities of those varieties raised upon the Sundance farm and the Laramie Farm in 1896 were determined. In Table XX we have given also the percent of starch as indicated by the specific gravities. The percents of starch corresponding to the specific gravities as given, were taken from a table in "Foods: Composition and analysis," by Blyth. As has been shown by investigations in other places, especially at the Virginia Station, the specific gravity of a potato is not an accurate indication of its starch content, but it is probable that the percents given do not vary more than two percent from the true amount.* The specific gravity will vary with the variety, the locality, and season and we have noticed considerable variation in a given crop of the same variety. For example, while selecting heavy seed potatoes for planting this season some tubers were found of Burpee's Superior which had a specific gravity of over 1.085 while the specific gravity for this variety given in the table is 1.073. In each variety as far as observed the smaller or medium sized tubers had a greater specific gravity than the larger ones.

The conditions at Laramie and Sundance are notably different. At Laramie the rainfall is about twelve inches per annum, and the potatoes are raised under irrigation,

*Also see "Principles and Practice of Agricultural Analysis," by H. W. Wiley.

while at Sundance the rainfall is about seventeen inches annually and the crops were raised without irrigation. The soils at the two places are also very different, but we believe the difference in altitude and consequent climate may have much to do in determining the specific gravity and percent of starch. It is probable that the starch content of potatoes raised at high altitudes will be less than that from lower altitudes. On this account potatoes raised under irrigation, at least above 6,000 feet, must be most carefully and intelligently handled or they are apt to be poor in starch. Potatoes rich in starch are more mealy and of better quality than those which are poor in starch. The potato crop at Laramie in 1896, on account of some climatic condition or too much irrigation was poorer than usual. Heretofore the potatoes raised upon the Laramie Plains have been of excellent quality and held in high esteem by the people here for table use. Potatoes raised at high altitudes also have been found excellent seed for planting in other places as their vitality and the change to which they are subjected produce beneficial results, giving larger yields and better potatoes.

TABLE XX.—*Specific Gravities and Per Cents Starch at Laramie and Sundance, 1896.*

No.	VARIETY.	LARAMIE.		SUNDANCE.	
		Specific gravity.	Starch, per cent.	Specific gravity.	Starch, per cent.
1..	Acme Seedling	1.074	12.7	1.109	20.1
2..	Albino	1.083	14.5	1.099	17.9
3..	Alexander Prolific	1.085	14.9	1.079	13.7
4..	Arizona	1.085	14.9	1.100	18.2
5..	Bill Nye	1.077	13.3	1.092	16.4
6..	Blue Victor	....	......	1.082	14.3
7..	Boston Red	1.087	15.4	1.101	18.4
8..	Brownell's Winner	1.083	14.5	1.091	16.2
9..	Burpee's Extra Early	1.082	14.3	1.095	17.1
10..	Burpee's Superior	1.073	12.5	....	....
11..	Charles Downing	1.071	12.1	1.099	17.9
12..	Chicago Market	1.077	13.5	....	....
13..	Clark's No. 1	1.084	14.7	1.096	17.3
14..	Dakota Red	1.084	14.7	1.089	15.8
15..	Delaware	1.081	14.1	1.095	17.1
16..	Early Market	....	......	1.099	17.9
17..	Early Minnesota	1.078	13.5	....	....
18..	Early Norther	1.089	15.8	1.103	18.8
19..	Early Ohio	1.080	13.9	1.100	18.2
20..	Early Rose	1.079	13.7	1.102	18.6
21..	Early Six Weeks	1.075	12.9	1.106	19.4
22..	Early Sunrise	1.076	13.1	1.102	18.6
23..	Empire State	1.076	13.1	1.089	15.8
24..	Freeman	1.090	16.0	1.091	16.2
25..	Koshkonong	1.071	12.1	1.089	15.8
26..	Late Puritan	1.078	13.5	1.086	15.1
27..	Mammoth Pearl	1.074	12.7	1.082	14.3
28..	Manitoba Rose	1.087	15.4	1.099	17.9
29..	Montana Wonder	1.083	14.5	....	....
30..	Monroe's Seedling	1.074	12.7	1.095	17.1
31..	Morning Star	1.082	14.3	1.108	19.9
32..	New Queen	1.084	14.7	1.092	16.4
33..	Ohio Junior	1.081	14.1	1.096	17.3
34..	Ohio Red	1.061	10.1	1.124	23.3
35..	Pearl of Savoy	1.081	14.1	1.098	17.7
36..	Polaris	1.082	14.3	1.108	19.9
37..	Pride of the West	1.071	12.1	1.081	14.1
38..	Reed's No. 86	1.076	13.1	1.101	18.4
39..	Rochester Rose	1.077	13.3	1.101	18.4
40..	Rose Seedling	1.076	13.1	1.085	14.9
41..	Rural Blush	1.081	14.1	1.089	15.8
42..	Rural New Yorker	1.084	14.7	1.087	15.4
43..	Snow Drop	1.073	12.5	....	....
44..	St. Patrick	1.086	15.1	1.089	15.8
45..	Summit	1.072	12.3	1.096	17.3
46..	Thornburn	1.080	13.9	1.090	16.0
47..	Vanguard	1.083	14.5	1.111	20.5
48..	White Elephant	1.081	14.1	1.089	15.8
49..	White Star	1.086	15.1	1.090	16.0
50..	World's Fair	1.085	14.9	1.093	16.6
	Average	1.081	14.1	1.096	17.3

Planting, Cultivation and Irrigation.

The months of heaviest rainfall in Wyoming are May and June, which generally give sufficient water supply to the soil to bring up all crops, but it is necessary to carefully conserve soil moisture. Some seasons, however, may be too dry, when it is best to irrigate before the land is plowed. The customary manner of planting is, first to well plow the land, then furrow with a plow, drop the potatoes and cover with a plow or "V." After planting, the ground should be thoroughly harrowed. It is important that the potatoes be dropped, covered and harrowed as soon as possible after the land has been furrowed. An experiment in 1896 upon the Laramie Farm demonstrates this in a conclusive manner. All the land was furrowed and several varieties were dropped and covered at once, before the soil had dried out, on May 13. Two days later some varieties were planted in the remaining furrows and after being covered the entire plat was harrowed. Those planted first made a good stand, practically all the seed growing. Of those planted after the furrows had dried out for two days only a few grew, possibly about ten percent.

The slight depressions left between the rows when potatoes are planted in this way may be of use should it become necessary to irrigate the potatoes up, a course which should never be resorted to unless absolutely necessary. Another method of planting which is quite extensively practiced upon the Laramie Plains is to drop in every third furrow while the land is being plowed. The advantage of retaining all the moisture possible is gained in this way, but on the other hand the plowing must necessarily be shallower than it otherwise might be, and unless the land has been well

plowed some time previously it is to be doubted whether it is the best method. However, where careful preparation is given beforehand this method is recommended.

Where care is taken to keep the soil moist and in good condition it will rarely be found necessary to irrigate the potatoes after they are planted to bring them up. Where irrigation for this purpose is unavoidable, shallow furrows should be made between the rows so that the land may be irrigated rapidly and without flooding. But little water will be necessary, at this time, and the less applied the less will be the cooling effect upon the soil.

About the time the potatoes are coming up they should be harrowed, preferably with the teeth of the harrow slanted backward to avoid cutting the young shoots. This is to kill the small weeds and also to break the crust forming a dust mulch on the surface which prevents evaporation. As soon as the crop is nicely up cultivation should begin and should be continuous till the plants are in bloom. It is best to give level cultivation, not banking the vines too much until just before irrigation when it will be necessary to make furrows between the rows in which to run the water.

The time to irrigate potatoes and the amount of water to be applied depends largely on the conditions of soil and climate and can only be determined by experience. A general rule to follow which will apply to most varieties is not to irrigate till the plants are in full bloom. From what observations we have made on this point we are led to believe that in general the potatoes set about ten days before they begin to bloom. Then if irrigation begins at the time of bloom, the sets having been formed, nearly all the tubers will grow to a marketable size, while, if irrigated earlier too many small potatoes will be set on the vines and few will reach a good size.

The first irrigation should be a thorough one, com-

pletely soaking the lower soil. After irrigating begins, the soil should not be allowed to dry out, as there is danger of the growth of the tubers being checked, and when wet again, of their starting to set small tubers a second time, or of sprouting to grow. In either case a failure of the crop might result. The furrow system of irrigation should invariably be practiced with potatoes. Never flood them or allow the water to reach the crown of the plants. After each irrigation as soon as the surface dries off and before it begins to bake, shallow cultivation should be given to break up the crust, keep the land mellow and a mulch of loose soil upon the surface.

It is better to avoid irrigating during hot, sultry weather, for if allowed to get too dry, the potato plants are weakened, and when irrigated at such a time good conditions for the attack of fungus diseases, such as blight, will prevail. Potatoes do not need a great amount of irrigation. They should not be allowed to suffer with drouth, but while better crops are produced with judicious irrigation the crop is often seriously injured by haphazzard application of water. Do not irrigate too often or too late. In the driest seasons three or four irrigations will generally be sufficient in any part of the state. The crop should be developed far enough by the middle of August for both irrigation and cultivation to cease.

Cost and Profit With Potatoes.

LARAMIE, 1894.—Cost per acre, including, fertilizer, seed, labor, etc.		$50 00
	Average yield of fifty varieties, 118.4 sacks.	
	Value of crop at 1c per pound	118 40
	Net profit per acre	$68 40
LARAMIE, 1895.—Cost per acre		$35 00
	Average yield of fifty varieties. 89.0 sacks per acre.	
	Value of crop at ½c per pound	44 50
	Net profit per acre	$ 9 50
LARAMIE, 1896.—Cost per acre		$31 50
	Average yield of fifty varieties, 91.4 sacks per acre.	
	Value of crop at ½c per pound	47 05
	Net profit per acre	$15 55
Average net profit at Laramie for three years with fifty varieties		$31 15
LANDER, 1894.—Cost per acre		$32 50
	Average yield of twelve varieties from treated and untreated seed. 86.88 sacks per acre.	
	Value of crop at 1c per pound	86 88
	Net profit per acre	$54 38
LANDER, 1895.—Cost per acre		$33 50
	Average yield of thirteen varieties, 66.66 sacks per acre.	
	Value of crop at 1¼c per pound	83 32
	Net profit per acre	$49 82

SUNDANCE, 1895.—Cost per acre................$15 00
Average yield of thirty-six varieties, 70 sacks per acre.
Value of crop at ¾c per pound.. 52 50

Net profit per acre...........$37 50

WHEATLAND, 1894.—Cost per acre..............$30 50
Average yield of nineteen varieties, 90.3 sacks per acre.
Value of crop at 1c per lb... 90 30

Net profit per acre..........$59 80

WHEATLAND, 1895.—Cost per acre..............$28 00
Average yield of thirty varieties, 44.1 sacks per acre.
Value of crop at ½c per lb.... 22 05

Loss per acre..............$ 5 95

WHEATLAND, 1896.—Cost per acre..............$24 00
Average yield of forty-five varieties, 32.2 sacks per acre.
Value of crop at 85c per hundred.... .... 27 37

Net profit per acre..........$ 3 37

Average net profit per acre at Wheatland for all varieties grown and three years..................$19 10

The above estimates of cost and profit with potatoes are based upon the reports of the superintendents of the experiment farms, and the cost given in most cases is an estimate of the actual cost of raising the potatoes grown in the experiments. Where actual cost is given it is high, for in the first place experimentation is expensive, and in the second place very small areas were grown, an acre or less in each experiment. Where small acres are grown the cost per acre would be more than upon larger areas. On the other hand, the small areas of potatoes grown for experiment would

probably produce larger yields as a rule than the yield upon larger areas, which would make the profit greater. At Lander in 1896 such small areas were grown of each variety that computing the yields per acre was not justifiable, at least for this purpose, so we have not made an estimate of cost and profit. The apparent large yields from these small areas makes the profit per acre amount to over $150. The average yield of so many varieties is lower than the yield from any of the better kinds. The last two seasons at Wheatland several of the varieties either produced very small yields or failed altogether. Averaging these in with the others made the yield so small that the crop grown in the experiment in 1895 cost more than it was worth at the local market price. The value of the crop is computed from the yield and the local wholesale market price for each place and year. Estimated cost and profit is not given at Saratoga or Sheridan, and for only one year at Sundance, as the estimated cost per acre and market price of crops were not given in reports from those places.

We believe that on large areas the total expense of raising and marketing a crop of pototoes under irrigation should not ordinarily exceed thirty dollars per acre. Taking our indicated average yield of 150 bushels per acre and an average price of one-half cent per pound, gives an average net profit of fifteen dollars per acre. The relation of potatoes to other crops on the farm, their place in the rotation of crops, and the favorable condition in which the soil is left by potatoes, together with a net profit of fifteen dollars or more per acre, gives them a high rank among our field crops.*

*For estimates of cost and profit with wheat in Wyoming, see Bulletin No. 25, Wyoming Station.

A Famous Authentic Yield of Potatoes in Wyoming and How It Was Obtained.

In answer to a letter to Mr. Herbert Myrick, editor of that standard and progressive agricultural paper, the "American Agriculturist," we have received the following account of a prize acre of potatoes grown upon the farm of Mr. Sturgis, in 1890. Mr. Sturgis' farm is situated upon the "Little Piney" creek in the northern part of the state. On account of its authenticity and value, along with the information in regard to methods of planting and raising potatoes, and to make it a matter of history in the state, the statement as received is published in full. The account appeared in "The American Agriculturist" for December, 1890.

"THE FIRST PRIZE CROP."

"*Where it was grown.*—Buffalo, in northern Wyoming, Johnson County, about latitude 44¼ degrees, has the honor of growing the greatest potato crop on record and of capturing the American Agriculturist first prize of $250 for the largest yield of potatoes on one measured acre in 1890, also a like prize offered by special act of the Wyoming Legislature to the man who would bring the American Agriculturist grand prize to that enterprising territory.

"The Contest Acre was a rich sandy loam, in its native state bearing a heavy growth of blue-stem grass, naturally dry, and worth about $20 per acre. The virgin soil was broken up for the first time in the spring of 1888, when it was planted to vegetables, without cultivation. In 1889 it was in garden crops, worked with a cultivator and shovel plow, but no manure of any kind was ever applied to it. It was plowed April 7, 1890, six to eight inches deep, with a Bradley

sulky plow and three horses, taking one man half a day. April 14 it was thoroughly harrowed by the Perfect harrow, drawn by three horses. It was marked out in furrows two and one-half feet apart and six inches deep, made by the sulky plow, the sets being dropped eight inches apart in the row, making 22,800 hills on the acre. The planting was done by one man from May 7 to 14, the ground damp and in good growing condition, but after that there was no more rain. The seed was all dropped and covered by hand. A thin board three inches wide, with three two-inch holes eight inches apart and eight inches from each end being used to drop by. The seed was covered two inches deep with a garden rake. When the potatoes came up, more earth was raked into the trench so as to almost cover the plant. The potatoes were cut with one, two and three eyes to a set, the piece being as large as the potato would admit of; 1,560 pounds of seed were used. About one-half the acre was planted with the Early Vermont variety the rest being Manhattan, Rural New Yorker No. 2, and three of Mr. Sturgis' own seedlings. The largest and best seed was selected from fifty bushels, but fully 3,000 hills did not come up, and were not replanted, as it was so late. In digging Mr. Sturgis found sets that were still sound and had never sprouted, and recommends to cut, plant and cover potatoes the same day, covering as fast as dropped,—as important suggestion in so dry a climate. The seed was all of his own raising.

"*Irrigation.*—The crop was fairly up June 12 when both soil and air were cool and dry. The single plow was run through the furrows on one-half the acre on June 18, a man with a hoe following and pulling the soil away from any plants that were covered, and pulling and cutting all weeds. Five days later the balance of the acre was gone over in the same way. On July 5 it was plowed out again, and July 7 was hoed and hand-weeded. On this day about one-third of the acre was irrigated, and by July 8 the whole acre had

been thoroughly watered by irrigation. It was irrigated twice a week until July 29, the weather being very dry, with no rain whatever.

"*The Harvest.*—On August 30 Mr. Sturgis notified the American Agriculturist that he should be ready to harvest his crop in the course of a fortnight or so. He began the work September 17, using a common twelve-inch Moline plow. One row on each side was plowed and the tubers picked up. Then two men with four-tined forks went over and forked out any potatoes that were covered up. Then two more rows were plowed and worked in the same way. About six days were occupied in harvesting, two men digging and three men picking up. The tubers were put in sacks containing 110 to 140 pounds, set in a wagon and hauled to the cellar, where they were weighed, on tested platform scales, as taken from the wagon, and then emptied into the bins in the cellar. An accurate tally was kept of all weighings and of the weight of the sacks. They were no other potatoes planted within eighty rods of the prize acre. Mr. Sturgis says the quality of the potatoes could not be surpassed in any way. They were not scabby, but were smooth, sound, and fine in every respect except from two places on the acre, where the water stood.

"The total yield was 58,488 pounds or 974 bushels and forty-eight pounds. Of these 50,320 pounds, or 838 bushels and forty pounds were merchantable tubers, and 8,168 pounds, or 136 bushels and eight pounds were small and unmerchantable. An average bushel of the larger size contained 102 tubers, and of the unmerchantable there were 462 potatoes in one bushel. The acre was measured May 17, by J. B. Mernardi, a sworn surveyor of Buffalo, in the presence of W. J. Thom and Sydney Sturgis. The harvesting was done in the presence of T. J. Keeser, J. M. Bennett, and Sydney Sturgis, who, with the contestant, William J. S. Sturgis, swore to the truth and accuracy of the harvesting

in every respect before N. L. Andrews, Notary Public and United States Commissioner, of Buffalo. The surveyor's certificate is sworn to before John T. Martin, Notary Public. The dimensions of the acre are 330 by 132 feet, containing just 43,500 square feet.

"The first prize of $250, offered by the "American Agriculturist" for the largest yield, is therefore, awarded to William J. S. Sturgis, of Buffalo, Wyoming, who is also entitled to $250 appropriated for this purpose by the Wyoming Legislature. His crop has certainly paid him handsomely. His expenses were as follows: Interest on value of land, $1.20; plowing, $2.00; harrowing, $2.00; furrowing, $1.00; value of seed, $15; cultivating, $5.00; irrigating, $8.00; harvesting, $40; total, $74.80.

"Mr. Sturgis is selling the crop at ninety cents per bushel, or $754.80 for the 838 2-3 bushels of marketable tubers; the small potatoes at twenty-five cents, are worth $34, making total receipts of $788.80. Deducting the expenses, we have $714 as the net profits on this first prize acre, exclusive of prizes."

PART II.

VARIETY TEST.

There are so many varieties of potatoes commonly grown that the limited number we have investigated can not be called an extensive variety test. Fifty sorts, mostly well-known kinds, were selected in the spring of 1894 and have been grown for three seasons. Not all of these varieties were planted upon each of the sub-stations though at Sheridan a larger number of kinds have been grown. Growing so many varieties has given more trustworthy results in the various experiments and has afforded better opoprtunity for the study of potatoes under our widely differing conditions. Growing the varieties for three consecutive seasons has enabled us to determine the more valuable kinds and has largely eliminated the effects of variations, which would decrease the value of the data by making it more unreliable if they were only grown a single season. The varieties have been arranged in the tables in the order of their yields, putting those first which yielded the largest crops. In general it may be stated that any of those varieties which stand near the top of the average tables for each farm will give satisfaction in the section of the state represented and can be recommended for general planting. As a rule the early varieties do not yield as large crops as medium or late kinds and this should be kept in mind when studying the tables. The dates that the tubers are ready for market and the condition of the vines at time of frost indicate whether the variety is early or late. It is of interest to note the difference in yield of the same variety in different years. For example

the Bill Nye gave the largest yield in 1895 at Laramie and stands at the top of the table for that year, while in 1896 it is number 29 in the list. On this account the average tables will be of the greatest practical value.

LARAMIE.

Tables XXI and XXII give the varieties grown at Laramie in 1891, 1892, and 1893. The yields of these years are not averaged in with the yields of 1894, 1895 and 1896 in table XXVI. The tables are self-explanatory. The yields given are of marketable potatoes expressed in sacks of 100 pounds each. This was done because in Wyoming farm crops are almost always bought and sold by the hundred pounds. The yields given in sacks may easily be converted into pounds or bushels if desired. Wherever we have used the term bushel in this bulletin a bushel of sixty pounds is meant.

In 1894, the first year the varieties were grown at this altitude, nearly half of them did not come into bloom. Some of them produced buds which were abortive, and fell off without opening. In 1895 only about one-fourth of the varieties failed to blossom and in 1896 about one-eighth of the total number failed to open their buds. In 1896 also many more of the varieties ripened their tubers than in 1895. It would seem that they have been adapting themselves to our conditions and that growing them a number of years in the same place causes potatoes to become acclimated. The varieties were all grown under the same conditions and treated alike. In 1894 and 1895 seed at the rate of 1,000 pounds per acre was used and in 1896 seed at the rate of 700 pounds per acre was used. Each year planting was done between May 9th and 13th. In 1894 the rows were two feet apart and in '95 and '96 two and one-half feet apart.

TABLE XXI.—*Potatoes, Laramie, 1891.*

No.	VARIETY.	Total Yield per acre in sacks of 1 cwt.	Per cent marketable	Yield marketable per acre in sacks of 1 cwt.
1	Early Rose	75.0	91	68.7
2	Beauty of Hebron	68.8	86	59.2
3	Chicago Market	66.8	87	58.1
4	California Rose	59.1	70	41.6
5	Mammoth Prolific	54.0	80	43.2
6	Rose Seedling	54.0(?)	88	47.6(?)
7	White Elephant	48.2	97	46.7
8	Mammoth Pearl	44.3	77	34.8
9	Early Puritan	42.2	78	32.8

TABLE XXII.—*Potatoes, Laramie, 1892 and 1893.*

VARIETY.	Yield per acre in sacks of 1 cwt. 1892	1893	VARIETY.	Yield per acre in sacks of 1 cwt. 1893.
Polaris	174	6.7	Beauty of Hebron	6.6
Early Maine	165	12.6	California Rose	8.9
Early Rose	164	10.4	Smooth Blue	31.9
Mogul	157	16.0	Clark's No. 1	35.5
Empire State	150	13.9	Early Puritan	4.1
Pride of America	116	7.0	White	26.0
Early Minnesota	114	20.2	White Elephant	16.6
Early Ohio		33.5	Snow Drop	16.6
Pink		35.6		

TABLE XXIII.—*Potatoes, Laramie, 1894.*

No.	VARIETY.	In bloom.	Condition of tops at time of frost.	Per cent marketable.	Yield marketable per acre in sacks of 1 cwt.	Weight of largest six.
						lbs.
1	Chas Downing	July 17	Ripe	95	313	2.7
2	Monroe's Seedling	" 17	Green	96	229	3.6
3	Early Norther	" 10	"	95	219	3.0
4	Burpee's Superior	" 17	"	95	212	3.6
5	Blue Victor	" 17	Ripening	96	199	6.3
6	Delaware		Green	95	185	4.2
7	Montana Wonder		"	96	173	5.2
8	Koshkonong		"	94	165	3.7
9	Boston Red		Ripening	87	163	2.3
10	Rochester Rose	" 17	Green	90	161	2.5
11	Manitoba Rose	" 17	"	88	159	2.7
12	Early Minnesota	" 17	"	89	155	2.5
13	Rural Blush	" 17	"	91	155	3.7
14	Late Puritan	" 17	"	93	154	4.3
15	Bill Nye	" 10	"	90	146	3.1
16	Arizona	" 17	"	91	145	3.2
17	Pearl of Savoy	" 10	"	87	141	2.6
18	Alexander Prolific	" 10	"	92	140	4.3
19	Rose Seedling		Ripening	95	138	3.2
20	Empire State		Green	88	136	2.3
21	Morning Star	" 17	"	91	133	2.7
22	Pride of the West		"	95	129	2.7
23	Thornburn	" 17	Ripe	87	127	2.2
24	World's Fair		Green	95	125	3.0
25	Early Rose	" 17	"	91	124	3.5
26	Snow Drop	" 17	"	89	123	3.0
27	Early Sunrise	" 17	"	83	120	2.2
28	Ohio Junior		Ripe	93	118	2.6
29	St. Patrick	" 10	Green	91	115	3.5
30	Brownell's Winner		"	84	106	2.2
31	Chicago Market	" 10	"	80	102	4.0
32	Clark's No. 1	" 17	"	84	101	1.7
33	White Star	" 10	"	91	100	3.0
34	Freeman		"	78	97	2.2
35	Rural New Yorker		Ripening	91	95	3.2
36	Vanguard	" 17	Ripe	82	89	1.5
37	Burpee's Extra Early	" 17	"	90	87	2.3
38	Mammoth Pearl		Green	93	79	4.1
39	Early Six Weeks		Ripe	91	74	1.7
40	Early Market		"	91	72	2.2
41	Polaris		"	77	66	1.7
42	Reed's No. 86		"	84	60	1.5
43	Albino		"	88	45	2.2
44	Acme Seedling	" 17	"	61	37	3.0
45	Summit	" 17	Green	48	36	2.9
46	Ohio Red		Ripe	50	26	2.1
47	Dakota Red		Green	51	18	2.0
48	Early Ohio		Ripe	61	17	1.8
49	New Queen		Ripening	38	11	1.3
50	White Elephant	" 17	"			3.3

TABLE XXIV.—*Potatoes, Laramie, 1895.*

No.	VARIETY.	Date of first bloom.	Length of vines when first in bloom.	Condition of vines at time of frost.	Per cent of total yield marketable.	Yield per acre marketable, in sacks of 1 cwt.	Weight of largest twelve.	Maturity of tubers.
			inches				*lbs.*	
1	Bill Nye	July 27	13	Green	87.2	143.8	7.2	Not ripe
2	Rural Blush	" 22	12	"	89.1	124.7	5.7	"
3	Morning Star	" 27	15	"	87.7	124.3	7.2	"
4	Pride of the West	" 29	15	"	91.7	124.0	7.0	"
5	Koshkonong	Aug. 9	14	"	90.7	117.5	9.2	"
6	Chas. Downing	July 30	16	"	85.3	117.3	6.0	"
7	Alexender Prolific	" 25	12	"	89.2	115.6	6.2	"
8	Delaware	" 23	12	"	87.9	115.0	7.6	"
9	Blue Victor	" 19*	11*	"	89.1	113.1	8.5	"
10	Manitoba Rose	" 27	14	"	85.9	112.2	7.0	"
11	Late Puritan	" 31	14	"	84.9	110.2	6.2	"
12	Clark's No. 1	" 29	13	Ripening	78.9	107.6	5.1	Ripe
13	Pearl of Savoy	" 31	13	Green	91.1	106.7	6.9	"
14	Early Sunrise	" 31	13	"	83.3	106.6	6.7	"
15	Burpee's Superior	" 30	15	"	88.0	105.2	5.5	"
16	Brownell's Winner	" 30	14	"	84.2	104.6	6.5	Not ripe
17	White Star	" 27	12	"	80.7	103.6	4.9	Ripe
18	Boston Red	" 19*	12*	"	89.3	102.4	5.2	Not ripe
19	St. Patrick	Aug. 3	14	"	88.4	100.1	6.0	"
20	Montana Wonder	July 31	14	"	91.0	98.1	6.8	"
21	Arizona	" 20	12	"	82.7	97.7	5.9	Ripe
22	Monroe's Seedling	Aug. 9	14	"	85.3	97.6	4.9	Not ripe
23	Early Northern	" 9	12	"	85.2	96.1	5.8	Ripe
24	Early Rose	July 31	13	"	87.1	94.5	6.3	Not ripe
25	Mammoth Pearl	Aug. 12	12	"	87.4	89.7	8.2	"
26	Chicago Market	July 23	11	"	87.4	88.3	6.9	"
27	Acme Seedling	" 16*	12*	Ripe	86.4	87.8	4.7	Ripe
28	Summit	" 31	13	Green	85.0	86.0	5.5	"
29	Early Minnesota	" 16*	10*	Ripe	77.1	80.8	4.8	Not ripe
30	Worlds Fair	Aug. 12	12	Green	87.8	80.8	4.8	Ripe
31	Burpee's Extra Early	" 3	15	"	78.2	80.4	5.2	"
32	Rochester Rose	" 3	14	"	84.8	79.5	5.8	Not ripe
33	Empire State	" 5	15	"	82.8	78.1	7.5	"
34	Rose Seedling	July 22	12	"	89.8	74.4	7.1	Ripe
35	Dakota Red	Aug. 20	15	"	63.6	74.2	4.8	Not ripe
36	Vanguard	July 31	12	Ripe	84.2	72.7	4.2	"
37	White Elephant	Ang 12	13	Green	81.8	72.1	3.6	"
38	Albino	July 22*	11*		68.1	70.5	3.8	Ripe
39	Snow Drop	Aug. 3	14	"	75.0	69.4	6.0	Not ripe
40	Reed's No. 86	July 31†	13†	Ripe	77.8	67.9	3.7	Ripe
41	New Queen	" 30†	11†	Green	71.9	67.1	3.8	Not ripe
42	Ohio Junior	" 23*	11*	Ripe	87.8	65.6	4.7	"
43	Early Six Weeks	Aug. 5‡	11‡	"	79.4	64.6	4.1	"
44	Ohio Red	July 22*	12*	"	83.6	62.4	4.5	"
45	Early Market	Aug. 5‡	11‡	"	80.7	56.9	4.5	"
46	Thornburn	July 25	11	Ripening	82.2	54.7	4.2	Ripe
47	Early Ohio	Aug. 12	12	Ripe	81.6	51.1	3.8	Not ripe
48	Freeman	July 25	11*	Green	65.7	47.2	3.8	"
49	Polaris	Aug. 12	12	Ripening	73.6	45.9	3.0	"
50	Rural New Yorker	" 9	14	Green	85.7	45.5	4.2	"

*Date of first bud and length of vine on same day.
†Buds abortive, and date when length of vine was taken.
‡No buds.

TABLE XXV:—*Potatoes, Laramie, 1896.*

No.	VARIETY.	Date of first bloom.	Length of vines when first in bloom.	Condition of vines at time of frost.	Per cent of total yield marketable.	Yield per acre marketable, in sacks of 1 cwt.	Weight of largest twelve.	Maturity of tubers.
			inches				*lbs.*	
1	Alexender Prolific	July 18	14	Green	88.7	164.2	8.0	Ripe
2	Deleware	" 17	15	"	91.2	159.4	8.5	"
3	Morning Star	" 17	16	"	91.8	147.3	10.0	"
4	Burpee's Superior	" 25	15	"	85.8	132.4	6.2	"
5	Mammoth Pearl	Aug. 4	16	"	91.5	128.8	9.0	"
6	Chas. Downing	July 25	14	"	89.2	125.2	6.6	"
7	St. Patrick	" 17	13	"	93.4	124.7	10.0	"
8	Manitoba Rose	" 28	18	"	89.0	124.5	7.1	"
9	Pearl of Savoy	" 20	13	"	93.7	122.0	9.8	"
10	Boston Red	Aug. 4	16	"	86.5	118.6	7.6	"
11	Blue Victor	" 1	14	"	91.8	116.7	9.5	"
12	Clark's No. 1	July 17	15	"	87.1	116.5	8.1	"
13	Empire State	" 25	14	"	92.3	115.2	7.5	"
14	Summit	" 20	12	"	92.2	113.9	7.6	"
15	Early Norther	" 20	15	"	90.6	109.8	8.7	Not ripe
16	Arizona	" 25	12	"	91.6	108.3	7.7	Ripe
17	Early Sunrise	" 17	13	"	89.8	107.6	8.0	"
18	Burpee's Extra Early	" 20	14	"	89.1	102.1	7.0	"
19	White Elephant	" 25	16	"	84.7	101.6	5.3	"
20	Reed's No. 86	" 20	14	"	90.9	100.8	9.0	"
21	Koshkonong	" 25	15	"	92.3	100.0	10.5	"
22	Albino	" 17	12	Ripe	90.8	99.0	6.5	"
23	Early Rose	" 18	14	Green	86.0	95.7	7.0	"
24	Freeman		12*	"	76.3	94.4	5.9	"
25	Snow Drop	" 25	15	"	82.2	94.1	7.1	"
26	Montana Wonder	" 25	13	"	96.1	91.6	9.7	"
27	New Queen	" 20	13	"	86.7	90.7	6.3	"
28	Brownell's Winner	" 28	15	"	92.5	89.1	7.7	"
29	Bill Nye	" 25	14	"	86.4	89.0	8.9	"
30	White Star	" 24	16	"	88.8	88.3	6.5	"
31	Chicago Market	" 18	15	"	94.4	87.7	8.8	" (?)
32	Early Minnesota	" 25	12	Ripe	87.8	83.0	6.2	"
33	Thornburn	" 20	14	"	85.9	82.7	7.1	"
34	Early Market		12*	"	93.9	79.4	7.0	"
35	Early Six Weeks	" 24	12	"	92.6	78.9	6.2	"
36	Ohio Junior		13*	"	95.9	78.4	6.5	"
37	Rochester Rose	" 24	12	Green	95.3	76.4	8.0	"
38	Polaris	" 20	13	"	85.3	73.7		"
39	Rural New Yorker	" 28	15	"	87.9	68.9	6.0	"
40	Acme Seedling		12*	"	91.4	68.8	6.6	"
41	Rural Blush	" 17	16	"	81.8	67.8	4.2	"
42	Late Puritan	" 27	13	"	89.1	66.9	8.0	Not ripe
43	World's Fair	" 28	14	"	86.8	66.2	5.5	"
44	Early Ohio		12*	Ripe	91.2	62.5	6.0	Ripe
45	Monroe's Seedling	" 28	15	Green	87.4	61.4	6.7	"
46	Rose Seedling	" 24	14	Ripe	94.8	58.7	7.2	"
47	Pride of the West	" 28	12	Green	89.5	58.5	6.3	"
48	Dakota Red	Aug. 4	16	"	71.8	52.5	4.5	Not ripe
49	Ohio Red		10*	"	87.3	39.3	6.5	
50	Vanguard	July 25	16	"	88.7	22.2	4.5	Ripe

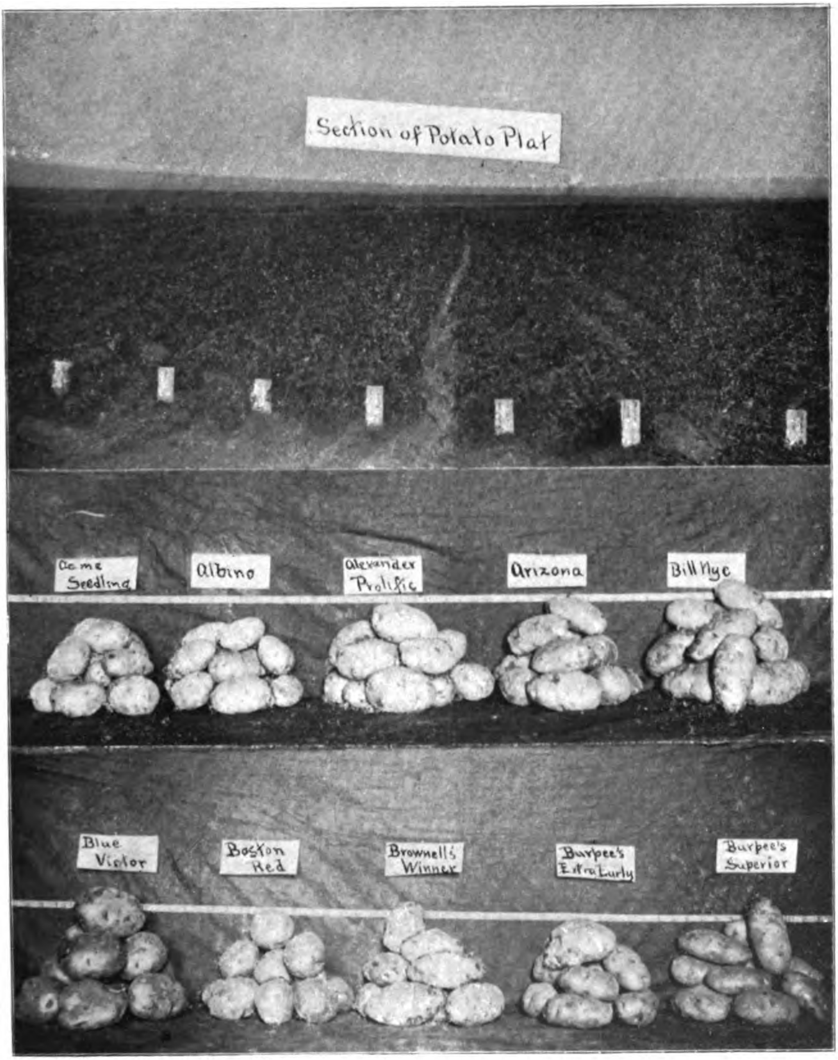
*Did not come into bloom. Length of vine taken Aug. 11.

TABLE XXVI.—*Potatoes, Laramie. Average of three years' crops.*

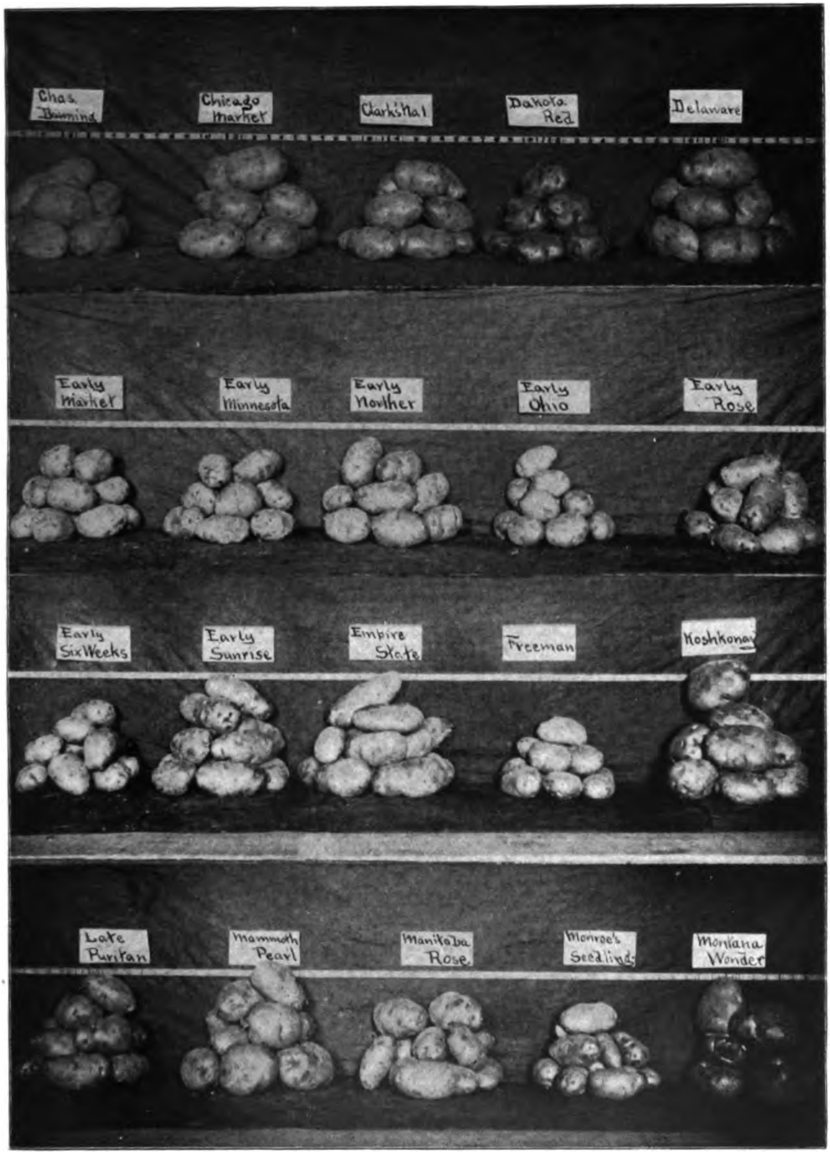
No.	VARIETY.	Average yield per acre marketable, in sacks of 1 cwt.	Average per cent marketable.	Average weight of largest twelve.
				lbs.
1	Chas. Downing	185.3	89.8	6.0
2	Delaware	153.1	91.4	8.1
3	Burpee's Superior	150.0	89.8	6.3
4	Blue Victor	142.8	92.5	10.2
5	Early Norther	141.8	90.2	6.8
6	Morning Star	134.7	90.0	7.6
7	Manitoba Rose	132.0	87.8	6.5
8	Alexander Prolific	129.9	89.8	7.7
9	Monroe's Seedling	129.2	89.6	6.3
10	Boston Red	127.9	87.6	5.8
11	Koshkonong	127.5	92.3	9.1
12	Bill Nye	126.1	87.8	7.4
13	Pearl of Savoy	123.2	90.6	7.3
14	Montana Wonder	120.9	94.4	8.8
15	Arizona	117.1	88.3	6.7
16	Rural Blush	115.7	87.1	5.6
17	St. Patrick	113.4	90.9	7.7
18	Early Sunrise	111.4	85.2	6.4
19	Late Puritan	110.4	88.9	7.7
20	Empire State	109.7	87.7	6.5
21	Clark's No. 1	108.5	83.3	5.6
22	Early Minnesota	106.2	84.7	5.3
23	Rochester Rose	105.8	90.1	6.2
24	Early Rose	104.7	88.3	6.8
25	Pride of the West	104.0	92.0	6.3
26	Brownell's Winner	99.8	86.9	6.2
27	Mammoth Pearl	99.1	90.5	8.4
28	White Star	97.5	89.7	5.8
29	Snow Drop	95.6	82.1	6.3
30	Chicago Market	92.5	87.3	7.9
31	World's Fair	90.5	89.8	5.4
32	Rose Seedling	90.4	93.2	6.9
33	Burpee's Extra Early	89.9	85.7	5.7
34	Thornburn	88.1	85.1	5.2
35	Ohio Junior	83.9	92.1	5.5
36	Freeman	79.6	73.3	4.7
37	Summit	78.5	75.2	6.3
38	Reed's No. 86	76.3	84.2	5.3
39	Early Six Weeks	72.4	87.8	4.5
40	Albino	71.5	82.4	4.9
41	Rural New Yorker	69.7	88.2	5.6
42	Early Market	69.3	88.6	5.4
43	Acme Seedling	64.5	79.8	5.8
44	Polaris	61.7	78.6	3.2*
45	Vanguard	61.3	84.9	3.9
46	New Queen	56.5	65.7	4.2
47	Dakota Red	48.4	62.3	4.4
48	Early Ohio	43.5	78.1	4.1
49	Ohio Red	42.6	73.6	5.0
	White Elephant	86.8†	83.2†	4.1†

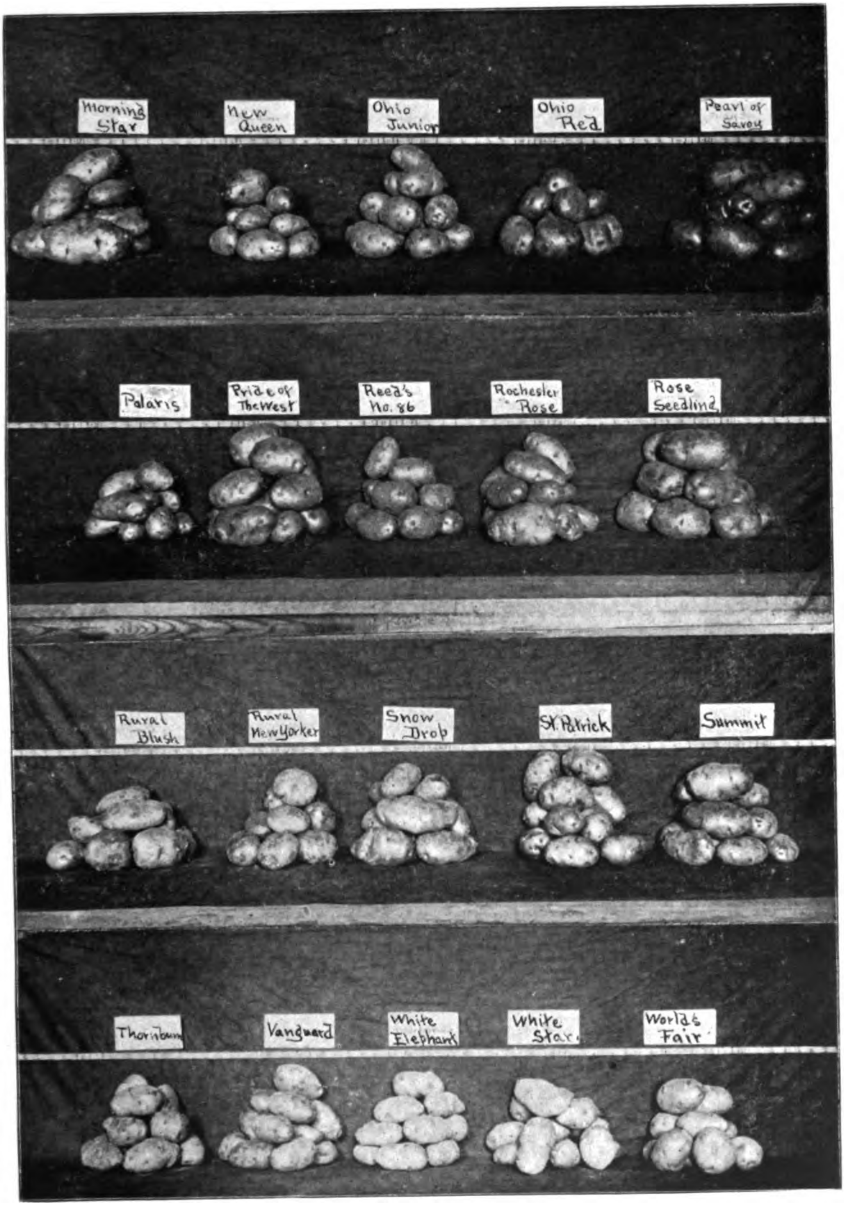
*Average for two years.

†Average for two years. In 1894 the total yield of White Elephant was 168.4 sacks. The per cent marketable was not taken. Assuming the per cent marketable to be 80, which is below its average, this would place this variety No. 26 in the list.



Section of Potato Plat
Acme Seedling
albino
alexander Prolific
arizona
Bill Nye
Blue Victor
Boston Red
Brownell's Winner
Burpee's Extra Early
Burpee's Superior


Chas. Downing
Chicago Market
Clark's No 1
Dakota Red
Delaware
Early Market
Early Minnesota
Early Norther
Early Ohio
Early Rose
Early Six Weeks
Early Sunrise
Empire State
Freeman
Koshkona
Late Puritan
Mammoth Pearl
Manitoba Rose
Monroe's Seedling
Montana Wonder


Morning Star
New Queen
Ohio Junior
Ohio Red
Pearl of Savoy
Polaris
Pride of The West
Reed's No. 86
Rochester Rose
Rose Seedling
Rural Blush
Rural New Yorker
Snow Drop
St. Patrick
Summit
Thorburn
Vanguard
White Elephant
White Star.
World's Fair

LANDER.

Tables XXVII to XXXI inclusive give the results with the varieties grown for four years. In 1893 the yields given are averages from two different plats. (See potatoes on different soils at Lander, page 6.) The rows were three and one-half feet apart and the seed was dropped twelve inches apart in the rows, the seed was cut leaving from one to four eyes to each piece and planted at the rate of from 300 pounds to 400 pounds per acre. They were irrigated four times. On August 29th a heavy rain fell which kept the ground so wet that the potatoes did not fully ripen. The largest twelve tubers from the twelve varieties weighed eighteen pounds.

In 1894 the potatoes were planted May 4th and 5th at rates of from 364 to 572 pounds per acre. The crop was injured somewhat by the "Utah Crickett."

In 1895 the potatoes were cut two eyes to the piece and were planted at the rate of from 500 pounds to 600 pounds per acre.

In 1896 twenty of the varieties were grown from seed sent from the Laramie farm. Only a small amount of each variety was grown, hardly enough to warrant the computing of yields per acre. The varieties grown from Laramie seed produced larger average yields than those from home grown seed. Those kinds of which seed was furnished from Laramie are indicated in the table by asterisks. Table XXXI gives the averages of all those varieties which were grown for four years.

TABLE XXVII.—*Lander, 1893.*

No.	VARIETY.	Yield in sacks of 1 cwt. each.	No.	VARIETY.	Yield in sacks of 1 cwt. each.
1..	Late Puritan	228.0	7	Beauty of Hebron	166.6
2..	Early Puritan	225.2	8	Pride of the West	141.5
3..	Early Mayflower	219.5	9	Early Rose	133.1
4..	Snow Drop	200.3	10	Jumbo	130.4
5..	White Elephant	199.0	11	Bill Nye	129.2
6..	Empire State	190.3	12	Vanguard	65.4

TABLE XXVIII.—*Lander, 1894.*

No.	VARIETY.	Date ripe.	Matured in days.	Yield per acre in sacks of 1 cwt. each	Weight of largest twelve.
					lbs.
1..	Early Mayflower	Oct. 8	150	144.5	7.5
2..	White Elephant	Oct 8	150	119.0	11.0
3..	Bill Nye	Oct. 8	150	106.8	7.5
4..	Beauty of Hebron	Oct. 8	150	98.0	8.5
5..	Empire State	Oct. 8	150	93.3	8.0
6..	Jumbo	Oct 8	150	92.7	10.0
7..	Early Rose	Aug. 3	91	76.6	7.5
8..	Early Puritan	Aug. 15	103	73.5	7.5
9..	Late Puritan	Oct. 8	150	73.2	8.0
10..	Triumph	Oct. 8	150	69.5	8.5
11..	Snow Drop	Oct. 8	150	59.0	7.5
12..	Vanguard	Oct. 8	150	33.5	7.5

TABLE XXIX.—*Lander, 1895.*

No.	VARIETY.	Date in bloom.	Date ready for market.	Matured in days.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve.
						lbs.
1..	Late Puritan	July 11	July 21	144	198.1	25.0
2..	White Elephant	" 11	" 20	145	186.3	22.0
3..	Triumph	" 16	Aug. 8	144	134.7	14.0
4..	Vanguard	" 11	July 20	145	132.1	17.0
5..	Early Rose	" 11	" 15	111	112.0	14.0
6..	Early Puritan	" 11	" 20	116	110.3	16.8
7..	Empire State	" 16	Aug. 12	144	108.5	9.0
8..	Bill Nye	" 16	" 15	144	86.0	11.0
9..	Early Mayflower	" 11	" 1	144	79.8	9.0
10..	Jumbo	" 16	" 14	144	63.9	15.0
11..	Beauty of Hebron	" 11	" 7	144	53.5	8.5
12..	Pride of the West	" 31	" 5	144	43.3	10.5

TABLE XXX.—*Lander, 1896.*

No.	VARIETY.	Date tubers set.	Length of vines when mature.	Ready for market.	Per cent marketable.	Yield marketable tubers in sacks of 1 cwt. each.	Weight of largest twelve.
			inches				lbs.
1	Mammoth Pearl*	June 23	34	Aug. 15	95.7	528	9.4
2	New Queen*	" 23	30	" 1	97.7	434	12.4
3	Arizona*	" 24	38	" 15	94.6	380	13.4
4	Brownell's Winner*	July 1	50	" 15	98.1	367	13.2
5	Early Minnesota*	June 23	30	July 15	97.1	359	10.7
6	Delaware*	July 1	48	Aug. 15	96.4	354	12.4
7	Koshkonong*	" 1	31	" 5	94.2	351	10.6
8	Dakota Red*	" 5	25	" 15	97.2	331	8.5
9	Blue Victor*	" 1	25	" 15	92.8	303	8.7
10	Albino*	June 30	36	" 5	96.1	252	8.5
11	Early Puritan	" 25	28	July 18		246	15.5
12	Triumph	July 1	29	" 12		233	14.5
13	Early Market*	June 23	26	" 15	95.7	230	8.8
14	Early Mayflower	July 1	37	Aug. 5		222	11.5
15	Manitoba Rose*	June 23	26	July 25	92.2	219	11.1
16	Boston Red*	July 1	26	Aug. 15	98.8	218	8.6
17	White Elephant	" 1	38	July 25		213	12.0
18	Ohio Red*	June 24	28	Aug. 5	96.7	210	8.8
19	Early Norther*	July 1	22	" 15	86.3	205	8.0
20	Early Rose	June 25	30	July 10		195	10.0
21	Early Six Weeks*	" 22	24	" 6	98.4	187	12.0
22	Jumbo	July 1	34	" 12		187	14.0
23	Alexander Prolific*	June 28	30	Aug. 15	91.2	186	6.5
24	Late Puritan	July 1	34	" 1		185	13.0
25	Bill Nye	" 1	33	" 10		184	8.5
26	Chicago Market*	June 22	28	" 5	96.2	178	8.4
27	Acme Seedling*	" 24	24	" 5	97.2	170	7.2
28	Chas Downing*	July 1	23	" 5	85.6	163	4.6
29	Beauty of Hebron	" 1	30	" 8		153	10.0
30	Snow Drop	" 1	32	" 12		152	7.0
31	Pride of the West	" 8	29	" 1		146	8.5
32	Vanguard	" 1	27	July 25		125	8.0

*Seed grown upon Laramie Farm, 1895.

TABLE XXXI.—*Average for Lander.*

No.	VARIETY.	Average yield for 4 years in sacks of 1 cwt. each.	Average weight for 3 yrs. of larg'st twelve.
			lbs.
1	White Elephant	179.3	15.0
2	Late Puritan	171.1	15.3
3	Early Mayflower	166.2	9.3
4	Early Puritan	163.7	13.3
5	Triumph	145.7	12.3
6	Snow Drop*	137.1	7.3
7	Empire State*	130.7	8.5
8	Early Rose	129.2	10.5
9	Bill Nye	126.5	9.0
10	Jumbo	118.5	13.0
11	Beauty of Hebron	117.8	9.0
12	Pride of the West*	110.3	9.5
13	Vanguard	89.0	10.8

*Average taken for two years.

SARATOGA.

Tables XXXII and XXXIII gives the results from the varieties grown upon the Saratoga farm in 1893 and 1894.

In 1893 they were planted May 16th and harvested September 28th.

In 1894 planting was done May 22d and harvesting September 28th, 480 pounds seed per acre being used. Since 1894 on account of lack of water the Saratoga farm has not been operated, and we have not averaged the results for the two years.

TABLE XXXII.—*Saratoga, 1893.*

No.	VARIETY.	Date in bloom.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve.
				lbs.
1	Blue Victor	July 28	188.1	8.0
2	Late Rose	" 24	184.8	10.0
3	Early Mayflower	" 7	176.7	6.0
4	Late Puritan	" 25	157.8	8.0
5	White Elephant	" 23	147.2	
6	Clark's No. 1	" 21	146.2	
7	Snow Drop	" 24	143.0	4.0
8	White Russett	" 27	131.6	
9	Early Sunrise	" 24	132.3	
10	Early Rose	" 20	122.4	
11	Vanguard	" 25	120.4	
12	Early Ohio	" 22	118.8	
13	Pride of the West	" 26	118.8	5.0
14	Beauty of Hebron	" 21	108.0	
15	Empire State	" 27	107.5	
16	Triumph	" 28	99.0	
17	Chas. Downing	" 25	89.0	

TABLE XXXIII.—*Saratoga, 1894.*

No.	VARIETY.	Date in bloom.	Date ripe.	Matured in days.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve.
						lbs.
1	Morton White	Aug 1	Sept 23	105	251.4	13.5
2	Triumph	July 23	" 23	105	220.8	12.0
3	Clark's No. 1	" 23	" 10	92	217.8	14.0
4	Eager's No 1	" 23	" 10	92	189.0	12.0
5	Early Ohio	" 20	" 10	92	180.0	9.0
6	Snow Drop	" 20	" 10	92	166.8	12.0

SHERIDAN.

In 1894 the potatoes were planted May 11th. No other notes were furnished except the yield for each variety as given in table XXXIV.

In 1895 they were planted April 26th in rows forty-two inches apart and hills twenty-four inches apart in the rows.

In 1896 they were planted May 7th at the rate of 700 pounds per acre. For complete data consult the tables XXXIV to XXXVII inclusive.

TABLE XXXIV.—*Sheridan, 1894.*

No.	VARIETY.	Yield in sacks of 1 cwt. each.	No.	VARIETY.	Yield in sacks of 1 cwt. each.
1	Dakota Red	200	29	Iron Clad	151
2	Rose Seedling	193	30	Chicago Market	151
3	Ohio Red	191	31	Rural Blush	149
4	Snow Drop	191	32	New Queen	147
5	Delaware	188	33	Thornburn	145
6	Summit	188	34	World's Fair	145
7	Rochester Rose	186	35	Blue Victor	143
8	White Star	186	36	Ohio Junior	143
9	Arizona	181	37	Maule's Freeman	142
10	Chas. Downing	174	38	Morning Star	142
11	Koshkonong	174	39	St. Patrick	142
12	Boston Red	171	40	Montana Wonder	136
13	Early Market	170	41	Rural New Yorker	136
14	Reed's No 86	170	42	Early Rose	135
15	Acme Seedling	168	43	Early Norther	132
16	Monroe's Seedling	168	44	Manitoba Rose	129
17	Brownell's Winner	165	45	Bill Nye	129
18	Burpee's Extra Early	165	46	Early Minnesota	126
19	Alexander Prolific	159	47	Early Ohio	125
20	Mammoth Pearl	159	48	Albino	122
21	Beauty of Hebron	159	49	Vanguard	121
22	Colorado Red	157	50	Early Six Weeks	116
23	Empire State	157	51	Pearl of Savoy	116
24	Clark's No. 1	156	52	White Elephant	115
25	Marquet	155	53	Polaris	101
26	Burpee's Superior	155	54	Pride of the West	99
27	Early Sunrise	155	55	Snow Drop No. 1	92
28	Hotel Favorite	155			

TABLE XXXV.—*Sheridan, 1895.*

No.	VARIETY.	Date in bloom.	Date ripe.	Matured in days.	Yield per acre in sacks of 1 cwt. each.	Weight of largest twelve.
						lbs.
1..	Bill Nye	July 30	Sept. 7	103	196	10
2..	Arizona	" 30	Aug. 25	101	195	11
3..	St. Patrick	" 28	Sept. 16	119	192	12
4..	Hotel Favorite	" 30	" 6	111	186	11
5..	Early Market	" 30	Aug. 26	108	184	10
6..	Empire State	" 30	Sept. 16	124	177	11
7..	Chicago Market	" 30	" 9	117	161	8
8..	Rural Blush	" 30	" 16	122	160	8
9..	Morning Star	" 25	" 5	109	157	10
10..	Clark's No. 1	" 25	Aug. 25	107	155	6
11..	Delaware	" 28	Sept. 10	122	154	9
12..	Montana Wonder	" 30	" 19	124	154	8
13..	Rochester Rose	None	Aug. 30	102	153	6
14..	Marquett	July 28	" 20	97	152	8
15..	Mammoth Pearl	None	Sept. 12	119	151	10
16..	Late Puritan	July 28	" 19	122	149	8
17..	New Queen	" 28	Aug 23	103	149	7
18..	White Elephant	" 20	Sept. 7	115	148	7
19..	Thornburn	" 28	Aug. 27	104	147	7
20..	Chas Dawning	" 28	" 20	97	146	8
21..	Dakota Red	" 29	Sept. 19	126	141	11
22..	White Star	" 30	" 4	112	140	10
23..	Rose Seedling	" 20	Aug. 28	105	140	6.5
24..	Pride of the West	" 30	Sept. 6	110	135	8
25..	Monroe's Seedling	None	" 12	119	134	7
26..	Brownell's Winner	July 30	" 10	118	131	8
27..	Rochester Rose	None	Aug. 28	100	130	7
28..	World's Fair	"	" 28	101	130	6
29..	Iron Clad	July 25	Sept. 10	113	128	8
30..	Burpee's Superior	" 29	" 16	120	126	7
31..	Beauty of Hebron	" 28	Aug 20	96	125	7
32..	Vanguard	" 20	" 28	107	124	6
33..	Pearl of Savoy	None	" 25	104	122	8
34..	Polaris	July 25	" 18	97	122	6
35..	Summit	" 30	" 28	102	122	8
36..	Burpee's Extra Early	None	" 15	93	120	6
37..	Manitoba Rose	July 28	" 27	106	120	7
38..	Rose Seedling	" 20	" 28	110	119	7
39..	Early Norther	None	" 27	104	118	8
40..	Koshkonong	"	Sept. 10	123	117	10
41..	Rural New Yorker	July 20	" 16	124	117	10
42..	Ohio Junior	None	Aug. 27	104	114	6
43..	Early Minnesota	July 30	" 22	102	110	7
44..	Reed's No. 86	None	" 27	109	107	9
45..	Colorado Red	"	" 27	103	99	7
46..	Early Sunrise	July 25	" 28	109	99	6
47..	Boston Red	" 28	Sept. 6	113	98	6
48..	Snow Drop	" 30	Aug. 28	105	91	5
49..	Blue Victor	None	" 27	101	90	9
50..	Albino		" 30	110	87	6
51..	Acme Seedling	July 25	" 27	104	83	6
52..	Alexander Prolific		" 26	102	82	4
53..	Maule's Freeman	None	" 20	100	82	6
54..	Early Six Weeks		" 22	103	79	6
55..	Early Ohio	July 28	" 17	99	77	6
56..	Ohio Red		" 28	107	69	5

TABLE XXXVI.—*Sheridan, 1896.*

No.	VARIETY.	In bloom.	Length of vines at maturity.	Date ripe.	Matured in days.	Per cent marketable.	Yield in sacks of 1 cwt.	Weight of largest twelve.
			inches					*lbs.*
1	Chicago Market	July 7	24	Sept. 19	109	87.7	129	5
2	Delaware	June 30	30	" 19	110	83.8	121	8
3	Monroe's Seedling	July 8	23	Aug. 30	90	81.8	121	6
4	Early Market	June 30	26	Sept. 19	111	84.4	117	7
5	Pearl of Savoy	" 30	18	Aug. 20	86	67.4	109	5
6	St. Patrick	July 15	17	Sept. 5	105	74.2	109	5
7	White Elephant	" 7	28	" 19	112	65.2	107	5
8	Burbank's Seedling	" 15	36	" 19	111	64.4	106	6
9	Mammoth Pearl	" 9	28	" 19	109	88.4	105	7
10	Burpee's Superior	" 8	20	" 19	110	70.6	104	7
11	Reed's No. 86	" 20	16	Aug. 30	94	85.3	100	6
12	Blue Victor	None	18	" 25	84	72.5	98	5
13	Iron Clad	July 7	16	Sept. 19	110	83.7	98	4
14	Late Puritan	June 30	16	" 20	112	67.9	95	5
15	Beauty of Hebron	" 30	20	" 20	116	87.0	94	5
16	Hepp's White	July 9	25	" 15	109	62.7	91	5
17	Alexender Prolific	" 10	23	Aug. 30	92	90.5	90	7
18	Vanguard	June 30	24	Sept. 30	127	75.6	90	5
19	Brownell's Winner	July 9	26	" 19	112	68.5	89	5
20	Marquett	" 6	20	Aug. 30	95	79.4	89	6
21	Bill Nye	" 9	25	Sept. 10	111	69.4	88	5
22	Chas. Downing	June 30	18	Aug. 30	91	84.7	88	5
23	Colorado Red	July 8	20	Sept. 20	112	70.8	88	5
24	Hotel Favorite	June 30	20	" 15	111	79.2	88	6
25	Clark's No. 1	" 30	18	Aug. 25	90	80.3	87	5
26	Albino	None	18	Sept. 10	101	77.1	85	6
27	Manitoba Rose	July 9	20	Aug. 20	89	82.8	85	6
28	Empire State	" 8	24	Sept. 15	104	57.2	83	4
29	White Star	" 7	28	Aug. 25	87	70.6	83	6
30	Summit	" 6	24	" 28	92	71.2	82	5
31	Rochester Rose	" 7	18	" 28	90	68.2	81	6
32	New Queen	June 30	20	" 25	90	80.3	79	5
33	Snow Drop	July 9	25	" 25	89	61.5	79	5
34	Arizona	June 30	28	Sept. 1	96	79.3	78	6
35	Early Minnesota	" 30	16	Aug. 27	83	70.3	78	5
36	Early Sunrise	July 8	16	Sept. 1	91	79.7	78	6
37	Koshkonong	" 8	16	" 15	105	70.3	78	4
38	Rural New Yorker	" 8	16	" 1	90	81.3	78	4
39	Morning Star	" 9	18	Aug. 15	76	81.0	77	6
40	Boston Red	June 30	18	" 10	72	67.8	72	3
41	Burpee's Extra Early	" 30	16	Sept. 10	107	89.6	72	7
42	Polaris	July 7	15	" 20	110	79.7	72	7
43	Rose Seedling	June 30	18	Aug. 25	84	81.4	72	5
44	Acme Seedling	July 9	18	" 15	77	87.7	69	7
45	Montana Wonder	" 15	20	Sept. 10	104	84.2	69	7
46	Ohio Junior	June 30	18	Aug. 17	78	78.0	66	4
47	Early Rose	July 8	28	" 30	89	77.1	65	5.5
48	Early Norther	June 30	26	" 30	90	74.0	62	5
49	Worlds Fair	July 9	36	Sept. 19	111	68.0	61	4
50	Thornburn	" 9	13	Aug. 30	90	81.8	54	6
51	Rural Blush	June 30	26	" 15	74	69.8	53	5
52	Early Ohio	July 1	18	" 21	87	83.7	52	7
53	Pride of the West	" 7	25	" 30	91	74.4	52	4
54	Ohio Red	None	12	" 25	83	82.0	48	5
55	Dakota Red	"	28	Sept. 19	109	67.6	41	3
56	Early Six Weeks	June 30	14	Aug. 25	90	78.8	38	4

TABLE XXXVII.—*Sheridan. Average yields for three years.*

No.	VARIETY.	Average yield for three years in sacks of 1 cwt. each.	Average weight for two years of largest twelve.
			lbs.
1..	Early Market	157.0	8.5
2..	Delaware	154.0	8.5
3..	Arizona	151.0	8.5
4..	St. Patrick	147.6	8.5
5..	Chicago Market	147.0	6.5
6..	Hotel Favorite	143.0	8.5
7..	Monroe's Seedling	141.0	7.0
8..	Empire State	139.0	7.5
9..	Mammoth Pearl	138.0	9.0
10..	Bill Nye	137.6	7.5
11..	Rochester Rose	137.5	6.0
12..	Rose Seedling	137.0	5.8
13.	White Star	136.0	8.0
14..	Chas. Downing	136.0	6.5
15..	Clark's No. 1	133.0	5.5
16..	Marquet	132	7.0
17..	Summit	131	6.5
18..	Burpee's Superior	128	7.0
19.	Brownell's Winner	128	6.5
20..	Dakota Red	127	7.0
21..	Reed's No. 86	126	7.5
22..	Morning Star	125	8.0
23..	White Elephant	125	6.0
24..	New Queen	125	6.0
25..	Iron Clad	125	6.0
26..	Beauty of Hebron	123	6.0
27..	Late Puritan*	122	6.5
28..	Rural Blush	121	6.5
29..	Montana Wonder	120	7.5
30..	Koshkonong	120	7.0
31..	Burpee's Extra Early	119	6.5
32..	Pearl of Savoy	116	6.5
33..	Thornburn	115	6.5
34..	Colorado Red	115	6.0
35..	Boston Red	114	4.5
36..	Vanguard	112	5.5
37..	World's Fair	112	5.0
38..	Manitoba Rose	111	6.5
39..	Early Sunrise	111	6.0
40..	Rural New Yorker	110	7.0
41..	Blue Victor	110	7.0
42..	Alexander Prolific	110	5.5
43..	Ohio Junior	108	5.0
44..	Acme Seedling	107	6.5
45..	Early Minnesota	105	6.0
46..	Early Norther	105	6.5
47..	Snow Drop	107	5.0
48..	Ohio Red	101	5.0
49..	Polaris	98	6.5
50..	Albino	98	6.0
51..	Pride of the West	95	6.0
52..	Early Ohio	81	6.5
53..	Early Six Weeks	78	5.0

*An average for two years only.

SUNDANCE.

The varieties of potatoes given in Table XXXVIII were planted April 16th, 1893, at the rate of 600 pounds seed per acre.

Table XXXIX gives the results obtained with the different varieties in 1895. They were planted May 14th at the rate of 560 pounds seed per acre.

In 1896 the varieties were planted on land sub-soiled and also on land not sub-soiled and the average for each variety is given in Table XL. The potatoes were planted May 8th at the rate of 680 pounds seed per acre.

Table XLI gives the averages of those varieties grown in 1893, 1895, and 1896. The variety test for 1894 is purposely omitted from this report.

Irrigation is not practiced on the Sundance farm, and consequently the potatoes were raised under conditions very different from those of the other farms.

TABLE XXXVIII.—*Sundance, 1893.*

No.	VARIETY.	Date ripe.	Date in bloom.	Matured in days.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve.
						lbs.
1...	Pride of the West	July 5	Sept. 15	135	59.2	7.5
2...	White Elephant	" 6	" 17	137	42.3	7.0
3...	Early Puritan	" 1	" 1	121	40.6	7.0
4...	Early Ohio	" 1	" 1	121	39.1	6.0
5...	Beauty of Hebron	" 1	" 1	121	34.8	6.0
6...	Early Mayflower	" 1	" 1	121	31.5	6.0
7...	Empire State	" 5	" 17	137	28.3	6.0
8...	Snow Drop	" 6	" 15	135	25.8	3.0
9...	Early Rose	" 1	" 1	121	22.9	5.0

TABLE XXXIX.—*Sundance 1895.*

No.	VARIETY.	Date in bloom.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve.
				lbs.
1..	Early Norther	July 13	101	8.0
2..	Pearl of Savoy	" 15	100	7.5
3..	Bill Nye	" 15	90	9.2
4.	Early Sunrise	" 15	90	9.3
5..	World's Fair	" 23	89	8.7
6..	Vanguard	" 15	85	7.7
7.	Empire State	" 23	84	6.7
8..	Morning Star	" 16	83	7.2
9..	Boston Red	" 18	83	6.0
10..	Arizona	" 18	81	7.7
11..	Pride of the West	" 18	80	6.7
12..	Rochester Rose	" 15	79	10.7
13..	Manitoba Rose	" 19	77	8.0
14..	Burpee's Extra Early	" 18	76	8.0
15.	Late Puritan	" 18	76	7.5
16..	White Elephant	" 23	76	7.3
17..	Polaris	" 15	74	9.0
18..	Koshkonong	" 23	73	7.5
19..	Alexander Prolific	" 18	70	7.1
20..	Chas Downing	" 18	70	6.2
21..	Snow Drop	" 18	70	5.7
22	Brownell's Winner	" 23	69	8.5
23..	St. Patrick	" 18	69	6.7
24..	Rose Seedling	" 15	69	7.5
25.	Thornburn	" 18	68	6.7
26..	Delaware	" 18	66	7.5
27..	Summit	" 18	66	7.7
28..	White Star	" 23	66	6.7
29.	Early Minnesota	" 18	62	7.0
30..	Reed's No. 86	" 18	57	7.0
31..	Chicago Market	" 18	54	9.2
32..	Clark's No. 1	" 18	40	9.2
33..	Rural Blush	" 22	39	6.0
34..	Acme Seedling	" 23	34	4.5
35..	Dakota Red	" 24	34	3.5
36..	Ohio Red	" 23	22	5.7

TABLE XL.—*Sundance, 1896.*

No.	VARIETY.	Date in bloom.	Date ripe.	Matured in days.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve.
						lbs.
1..	Early Rose	July 13	Sept. 30	113	128	5.5
2..	Blue Victor		Oct. 2	115	121	5.5
3..	Chicago Market	" 15	" 5	118	93	5.0
4..	Freeman		" 2	117	87	5.0
5..	Early Six Weeks	" 18	Sept. 1	85	84	7.0
6..	White Elephant	" 13	Oct. 5	119	81	5.0
7..	Burpee's Extra Early	" 13	Sept. 8	91	80	7.5
8..	Burpee's Superior	" 13	Oct. 2	118	79	4.5
9..	Early Market	" 13	Sept. 15	97	78	8.0
10..	Morning Star	" 15	Oct. 7	120	78	4.0
11..	Empire State	" 18	" 5	118	76	4.5
12..	Alexander Prolific	" 18	" 5	117	75	5.5
13..	Ohio Junior	" 13	Sept. 8	100	75	8.2
14..	Albino	" 13	" 15	97	73	5.5
15..	New Queen	" 10	Aug. 30	82	73	7.0
16..	Brownell's Winner	" 21	Oct. 5	117	72	5.0
17..	Mammoth Pearl	" 18	" 2	115	72	5.5
18..	Monroe's Seedling	" 23	" 2	114	71	5.0
19..	St. Patrick	" 18	" 5	117	70	5.5
20..	Boston Red	" 10	Sept. 15	94	70	5.2
21..	White Star	" 23	Oct. 6	119	69	4.5
22..	Rural New Yorker	" 24	" 2	114	68	4.5
23..	Delaware	" 10	" 2	114	67	6.0
24..	Rose Seedling	" 14	" 5	125	67	6.0
25..	Clark's No. 1	" 16	" 1	114	64	6.0
26..	Early Sunrise	" 15	" 1	113	62	6.0
27..	Thornburn	" 24	" 5	117	57	5.5
28..	World's Fair	" 19	" 5	117	57	5.0
29..	Early Market	" 10	Sept 15	97	56	5.5
30..	Snow Drop	" 18	Oct. 3	115	56	4.5
31..	Arizona	" 13	Sept. 30	113	55	5.0
32..	Manitoba Rose	" 13	Oct. 5	118	55	6.0
33..	Polaris	" 25	Sept. 15	99	55	5.0
34..	Reed's No. 86	" 25	Oct. 1	113	54	4.7
35..	Dakota Red	" 30	" 5	118	54	7.0
36..	Early Rose		" 1	112	54	6.5
37..	Pride of the West	" 17	" 7	113	52	5.0
38..	Koshkonong	" 24	" 5	117	50	5.0
39..	Rochester Rose	" 13	" 5	118	50	5.0
40..	Acme Seedling	" 23	" 8	120	48	7.0
41..	Chas Downing	" 27	" 5	117	48	5.2
42..	Ohio Red	" 25	Sept. 15	97	47	5.0
43..	Vanguard	" 16	" 15	99	47	5.0
44..	Bill Nye	" 10	Oct. 6	120	45	5.0
45..	Summit	" 15	" 5	118	45	5.0
46..	Early Norther	" 15	" 1	114	38	4.5
47..	Pearl of Savoy	" 15	Sept. 30	109	36	6.0
48..	Rural Blush	" 25	Oct. 3	115	29	4.0
49..	Late Puritan	" 16	" 5	119	22	5.0

TABLE XLI.—*Average Potato Crop at Sundance for Two Years.*

No.	VARIETY.	Average yield for two years in sacks of 1 cwt.	Average weight for 2 years of largest twelve.
			lbs.
1	Morning Star	80.5	5.6
2	Burpee's Extra Early	78.0	7.8
3	Boston Red	76.5	5.7
4	Early Sunrise	76.0	7.6
5	Early Rose	75.5	4.4
6	Chicago Market	73.5	7.1
7	World's Fair	73.0	6.9
8	Alexander Prolific	72.5	6.3
9	Brownell's Winner	70.5	6.8
10	Early Norther	69.5	6.3
11	St. Patrick	69.5	6.1
12	Rose Seedling	68.0	6.8
13	Pearl of Savoy	68.0	6.8
14	Arizona	68.0	6.4
15	Bill Nye	67.5	7.1
16	White Star	67.5	5.6
17	Delaware	66.5	6.8
18	White Elephant*	66.4	6.4
19	Manitoba Rose	66.0	7.0
20	Vanguard	66.0	6.4
21	Rochester Rose	64.5	7.9
22	Polaris	64.5	7.0
23	Pride of the West*	63.7	6.4
24	Empire State*	62.8	5.7
25	Koshkonong	62.5	6.3
26	Thornburn	62.5	6.1
27	Chas. Downing	59.0	5.7
28	Summit	55.5	6.4
29	Reed's No. 86	55.5	5.9
30	Clark's No. 1	52.0	7.6
31	Snow Drop*	50.6	4.3
32	Late Puritan	49.0	6.8
33	Dakota Red	44.0	5.3
34	Acme Seedling	40.5	5.8
35	Ohio Red	34.5	5.4
36	Rural Blush	34.0	5.0

*Average for three years.

WHEATLAND.

In 1894 (Table XLII), the potatoes were planted May 7th in rows three feet apart. The land had been prepared by plowing under a crop of alfalfa while in full bloom the previous season. The potatoes were irrigated five times, the first on May 30th to bring them up.

In 1895 (Table XLIII), they were planted May 13th, in rows three feet apart, the seed was cut two eyes to the piece and dropped twelve inches apart in the rows. The land was alfalfa ground plowed in August, 1894.

In 1896 (Table XLIV), they were planted May 12th, in rows three feet apart, the pieces being dropped eighteen inches apart in the rows. This gave 248 pounds of seed to the acre. They were irrigated three times, the first on May 26th to bring up the crop.

Table XLV gives the averages for the three years.

TABLE XLII.—*Potatoes, Variety Test, Wheatland, 1894.*

No.	VARIETY.	Date in bloom.	Date ripe.	Matured in days.	Yield per acre in sacks of 1 cwt.	Weight of largest twelve.
						lbs.
1..	White Elephant	July 10	Oct. 9	116	170.4	25.5
2..	Early Mayflower	" 10	Aug. 1	46	117.2	8.1
3..	Mammoth Pearl	" 25	Oct. 10	128	114.0	29.8
4..	Early Puritan	" 10	Aug. 15	61	108.7	16.0
5..	Early Rose	" 10	" 1	46	104.9	6.2
6..	Gov. Rusk	" 16	Oct. 10	117	99.3	23.1
7..	Vanguard	" 25	" 10	127	93.5	22.9
8..	Jumbo	" 18	" 10	127	88.9	20.5
9..	Hoffman	" 10	" 9	116	85.4	19.4
10..	Bill Nye	" 16	" 10	127	83.5	23.5
11..	Late Puritan	" 16	" 10	127	82.9	18.1
12..	Empire State	" 5	" 10	117	78.3	16.6
13..	Beauty of Hebron	" 25	" 10	127	77.9	12.0
14..	Snow Drop	" 10	" 9	116	73.9	18.6
15..	Triumph	" 18	" 10	127	72.0	23.5
16..	Rose Seedling	" 15	" 9	116	68.9	29.0
17..	New Burbank	" 25	" 10	127	67.3	20.2
18..	Early Ohio	" 10	Aug. 5	51	66.2	8.1
19..	Pride of the West	" 25	Oct. 10	127	65.0	17.4

TABLE XLIII.—*Potatoes, Variety Test, Wheatland, 1895.*

No.	VARIETY.	First bloom.	Last bloom.	Date ripe.	Matured in days.	Total yield in sacks of 1 cwt.	Per cent marketable.	Weight of largest twelve.
								lbs.
1	Rose Seedling	July 11	Aug. 10	Oct. 1	120	156.0	82.5	16.2
2	Rural New Yorker	" 10	July 27	Sept. 30	115	110.4	71.2	13.1
3	Early Mayflower	" 2	" 10	Aug. 24	83	104.2	71.9	11.0
4	Mammoth Pearl	" 12	" 20	Sept. 15	101	102.7	75.9	14.0
5	Late Puritan	" 8	" 25	" 30	112	89.7	71.7	8.5
6	Jumbo	Aug. 6	Aug. 15	" 19	105	84.5	80.0	10.7
7	Alexander Prolific	July 10	July 22	" 30	115	74.1	78.1	8.8
8	Hoffman	" 12	" 24	" 30	116	74.0	56.1	8.6
9	Clark's No. 1	" 15	Aug. 1	" 30	111	65.0	71.0	9.0
10	Early Rose	" 1	July 15	Aug. 10	69	64.3	74.7	8.9
11	Gov. Rusk	" 10	" 27	Sept. 30	120	61.8	70.5	9.2
12	Reed's No. 86	" 8	" 25	" 30	118	61.3	71.9	7.5
13	Morning Star	" 9	" 20	" 30	120	59.1	69.2	7.0
14	Boston Red	" 9	" 20	" 30	120	57.8	69.2	9.5
15	Empire State	" 9	" 20	" 12	102	55.2	58.8	13.1
16	Vanguard	" 9	" 29	" 30	116	53.3	69.5	11.8
17	White Elephant	" 12	" 24	" 20	102	52.8	76.7	13.7
18	Early Puritan	" 6	" 14	Aug. 15	74	49.4	68.5	6.5
19	Sunrise	" 7	" 12	Sept. 30	120	47.2	74.1	8.0
20	New Burbank	" 12	" 27	" 30	120	46.1	71.8	10.6
21	Bill Nye	" 8	" 20	" 30	116	44.2	63.2	6.6
22	Freeman	" 12	" 21	" 12	102	43.5	56.7	8.0
23	Polaris	" 9	" 15	" 30	111	42.9	77.3	8.4
24	Acme Seedling	" 12	" 20	" 30	112	41.6	75.0	7.0
25	Early Ohio	" 4	" 15	Aug. 24	83	39.7	83.6	8.5
26	Snow Flake	" 10	" 20	Sept. 30	116	39.0	50.0	7.9
27	White Star	" 12	" 25	" 30	111	38.3	62.7	6.5
28	Beauty of Hebron	" 11	" 24	" 30	116	35.8	80.0	9.0
29	Triumph	" 20	Aug. 1	.....*	..*	32.5	80.0	6.2
30	Pride of the West	" 12	July 25	Sept. 17	98	31.8	59.2	7.7

*Did not mature.

TABLE XLIV.—*Potatoes, Variety Test, Wheatland, 1896.*

No.	VARIETY.	Date in bloom.	Date ripe.	Matured in days.	Length of vines.	Total yield in sacks of 1 cwt.	Per cent marketable.	Weight of largest twelve.
					inches			*lbs.*
1	Early Market	July 20	Sept. 20	102	15	83.1	87.3	12.5
2	Early Minnesota	" 15	" 15	99	14	72.7	81.0	10.0
3	Ohio Junior	" 17	" 15	99	14	71.9	77.6	12.0
4	Sunrise	" 15	Oct. 2	116	19	70.1	72.6	8.0
5	Manitoba Rose	" 13	" 12	126	14	69.5	72.3	8.0
6	New Queen	" 15	" 12	125	18	69.4	74.1	8.1
7	Burpee's Extra Early	" 12	Sept. 5	89	15(?)	68.8	67.6	7.5
8	Ohio Red	" 17	Oct. 12	126	17	67.0	72.2	7.2
9	Early Norther	" 20	Sept. 15	99	13	66.9	71.4	8.5
10	Montana Wonder	" 18	Oct. 12	126	24	65.1	80.0	9.0
11	Pearl of Savoy	" 13	" 12	126	18	63.9	72.8	8.0
12	Delaware	" 15	" 12	126	16	63.2	51.0	8.5
13	Monroe's Seedling	" 14	" 12	109	16	63.2	58.9	8.0
14	Thornburn	" 16	" 12	126	12	63.2	71.5	8.5
15	Rural New Yorker	" 14	" 12	125	25	62.0	58.0	10.7
16	Rochester Rose	" 18	" 12	124	17	61.4	65.6	7.0
17	Early Six Weeks	" 15	Sept. 15	90	18	59.5	75.0	11.2
18	Alexander Prolific	" 24	Oct. 12	124	16	58.9	50.5	7.4
19	Polaris	" 20	" 12	126	24	58.0	64.1	10.0
20	Boston Red	" 19	Sept. 18	101	12	57.7	52.7	8.2
21	Early Rose	" 12	" 10	94	12	54.9	51.7	8.6
22	White Star	" 17	Oct. 12	126	20	52.7	49.4	6.5
23	Burpee's Superior	" 12	" 12	122	18	49.6	56.2	5.0
24	Clark's No. 1	" 15	" 12	126	16	48.5	48.8	8.2
25	Early Ohio	" 20	Sept 12	95	12	48.4	68.4	7.7
26	Morning Star	" 18	Cct. 12	126	22	48.4	57.7	6.6
27	Reed's No. 86	" 18	" 12	126	21	47.1	64.5	7.1
28	White Elephant	" 18	" 12	126	21	46.5	60.0	7.2
29	Arizona	" 12	" 12	122	15	45.9	71.6	8.5
30	St. Patrick	" 8	" 12	124	19	44.6	59.7	7.0
31	Koshkonong	" 18	" 12	124	17	41.7	66.7	8.0
32	Vanguard	" 18	" 12	126	17	39.1	60.3	6.6
33	Rural Blush	" 18	" 12	124	26	39.0	00.0	1.0
34	Rose Seedling	" 16	Sept, 18	102	17	38.4	68.1	13.1
35	Blue Victor	" 15	Oct. 12	124	18	37.2	75.0	7.0
36	Empire State	" 16	" 12	125	19	36.6	67.8	9.9
37	Early Suurise	" 15	" 12	124	15	35.2	63.0	7.8
38	Snow Drop	" 18	" 12	126	23	33.3	63.0	7.5
39	Bill Nye	" 22	" 12	124	24	31.0	00.0	3.0
40	Chicago Market	" 19	" 12	125	20	29.8	70.9	6.5
41	Late Puritan	" 15	" 12	126	22	28.1	49.8	6.1
42	Pride of the West	" 20	" 12	126	20	26.7	53.5	6.5
43	Mammoth Pearl	" 17	Sept. 15	99	12	25.4	65.8	8.1
44	Acme Seedling	" 23	Oct. 12	126	14	22.1	69.1	7.1
45	Brownell's Winner	" 17	" 12	126	23	18.9	00.0	0.8

TABLE XLV.—*Wheatland, Average for Three Years.*

No.	VARIETY.	Average yield in sacks of 1 cwt.	Average per cent market-able.	Aver-age weight largest twelve.
				lbs.
1..	Early Mayflower*	110.7		9.5
2..	White Elephant	93.2	68.3	15.5
3..	Rose Seedling	87.8	75.3	19.4
4..	Jumbo*	86.7		19.2
5..	Rural New Yorker†	86.2	64.6	11.9
6..	Mammoth Pearl	80.7	71.9	17.3
7..	Gov. Rusk*	80.6		17.7
8..	Hoffman*	79.7		14.0
9..	Early Puritan*	79.0		11.3
10..	Early Rose	74.7	63.2	7.9
11..	Late Puritan	66.9	60.8	10.9
12..	Alexander Prolific†	66.5	64.3	8.1
13..	Vanguard	62.0	64.9	13.8
14..	Sunrise†	58.7	73.4	8.0
15..	Boston Red†	57.8	61.0	8.9
16..	Beauty of Hebron*	56.9		10.5
17..	Clark's No. 1†	56.8	59.9	8.6
18..	Empire State	56.7	63.3	13.2
19..	New Burbahk*	56.7		15.4
20..	Reed's No. 86†	54.2	68.2	7.3
21..	Morning Star†	53.8	63.5	6.8
22..	Bill Nye	52.9	31.6	11.0
23..	Triumph*	52.3		14.9
24..	Early Ohio	51.4	76.0	8.1
25..	Polaris†	50.5	70.7	9.2
26..	Snow Drop	48.7	56.5	11.3
27..	White Star†	45.5	56.0	6.5
28..	Pride of the West	41.2	56.4	10.8
29..	Acme Seedling	31.9	72.0	7.0

*Grown only in years of '94 and '95.
†Grown only in years of '95 and '96.

Variety Notes.

Among any fifty varieties of potatoes selected from various seed catalogues it is very likely that there will be some duplicates. Careful study of all the varieties grown upon the home farm show a number which resemble closely and several which are undoubtedly duplicates.

Our field notes and careful comparison of the tubers show practically no difference between Chicago Market and Rose Seedling. Burpee's Extra Early and Thornburn seem identical. Acme Seedling and Early Market seem to be the same. Apparently there is not enough difference between Rochester Rose and Arizona to entitle them to separate names and Summit and Early Rose closely resemble each other. Koshkonong seems to be an improved Mammoth Pearl, the only apparent difference being larger yields from the former. Careful comparison of many other varieties fail to detect any important difference in the tubers themselves but differences in the plants, their season, and time of coming into bloom present sufficient variation to prevent further combinations. Old varieties are often given new names by ambitious seedsmen, pèrhaps after being improved, the new names aiding in advertising and selling to all those who are anxious to procure something new or better than they already have.

The keeping qualities of the different varieties vary in much the same manner as the keeping qualities of different kinds of apples, though the variation is not so marked with potatoes. In general early varieties do not keep as well as late, but there is marked differences among the late varieties in this respect. We have experienced no difficulty in keep-

ing all kinds over winter. If not fully ripe when harvested they are apt to wilt. This was observed with Thornburn, Polaris, Freeman and Early Sunrise. The tubers of these varieties seemed ripe when dug but the tops were large and green up to the time of killing frost. The poorest keepers the past season were the Pearl of Savoy and Early Six Weeks. The other varieties which did not keep perfectly were Monroe's Seedling, Rural New Yorker, Arizona, Rochester Rose, Ohio Red, Delaware, Bill Nye and Albino. The other varieties have kept well. The one kind that can be depended upon to keep longer than any other on the list is the Blue Victor. On account of its color it does not sell well in many markets though in Sheridan County it is becoming quite a favorite. In a cellar or pit where the conditions of temperature and ventilation are favorable this variety may readily be kept for more than one season. The tubers are large, kidney or heart shaped, dark purplish or pinkish blue in color, often mottled with a lighter shade, skin tough, flesh very firm and, like a Ben Davis apple they, apparently never spoil.

VARIETIES.

We describe only a dozen varieties that have given the best yields at Laramie. These are the first twelve given in table XXVI on page —. Among the dozen and a half kinds in the table which follow this first twelve will be found many standard varieties which are good yielders. The greater number of the early sorts are near the bottom of the table.

Charles Downing:—Seed was obtained from Peter Henderson in the winter of '93 and '94. It is not a large potato but is of a fine shape for market, being oval elliptical,smooth and regular; skin is slightly roughened and dull yellowish white; eyes very small, few and shallow; medium late.

Delaware:—Seed from Vaughan's in the winter of '93 and '94. Potatoes of fair shape, large, long oval, flattened,

irregular and rather rough; skin rough, dull white; eyes medium in number and size.

Burpee's Superior:—Seed from Barteldes & Co., in winter of '93 and '94; size fair but shape rather poor for market; tubers long, round, tapering toward the ends and irregular; skin smooth, white; eyes medium in number and small; medium late.

Blue Victor:—Seed from Barteldes & Co., in winter of '93 and '94; tubers large and irregular, generally flattened, heart shaped; skin somewhat rough, purplish or pinkish blue with small dark purple specks and often mottled with lighter shades; eyes few, large and scattered, either shallow or prominent; good keepers and excellent shape for market; late.

Early Norther:—Seed from Peter Henderson in the winter of '93 and '94; tubers of good size and shape, elongated elliptical, flattened; skin smooth, pinkish white; eyes medium large and rather deep, pink especially at the seed end; early.

Morning Star:—Seed from Peter Henderson in the winter of '93 and '94; of good size, long oval, tapering slightly and flattened; skin yellowish white, rough; eyes large numerous and deep; medium late.

Manitoba Rose:—Seed was obtained from Northrup, Braslan, Goodwin & Co. in the winter of '93 and '94; pinkish white with darker pink shades at the ends, especially at the seed end; skin smooth and shiny; eyes large, numerous, and quite deep, with rudimentary leaf projecting over the eye pit; shape cylindrical, slightly tapering at either end, a fine looking potato; medium in season.

Alexander Prolific:—Seed was obtained from Vaughan's in the winter of '93 and '94; white with slightly bronze yellowish tinge, large, smooth, long oval, regular in shape, slightly flattened; eyes few, large but shallow; skin

speckled with numerous dark pin specks; medium early.

Monroe's Seedling:—Seed from Barteldes & Co., in the winter of '93 and '94; dull yellowish white, small cylindrical and regular; skin smooth with rather conspicuous flecks; eyes rather numerous and large but very shallow; late.

Boston Red:—Seed from Lee-Kinsey in the winter of '93 and '94; pink with white streaks; shape spherical or nearly so, regular; skin smooth with minute scattering flecks; eyes large, few, shallow, some protruding; medium in season.

Koshkonong:—Seed from Vaughan's in the winter of '93 and '94; dull yellowish white, dotted with minute flecks; large, oval shaped; flattened, regular, a fine shape for market; skin a little rough; eyes few, large, medium in depth; late.

Bill Nye:—Seed from Peter Henderson in the winter of '93 and '94; white, yellowish tinge, slight scattering pin specks; long, slightly flattened, tapering toward each end, regular, rather poor shape for market; eyes large, deep, with a rudimentary leaf projecting over the eye pit; skin smooth but not shiny; medium to late.

SUMMARY.

Soil Work:—At Lander potatoes on bottom land gave more than twice the yield that they did on upland.

At Sheriadn sub-soiled land gave 21 percent more yield than that not sub-soiled; at Sundance, 18.5 percent; and at Wheatland, 18.4 percent.

A gain of over 38 percent in yield was obtained by plowing under a crop of peas the previous season.

Insect Enemies and Diseases:—The potato beetle does no harm on the Laramie Plains, but is injurious in other parts of the state at lower altitudes.

The "Utah cricket" has done some damage at Lander.

The "potato maggot" is present on the Laramie Plains, but as yet no serious loss has been reported.

The treatment of potatoes for scab proved somewhat detrimental to the yield at Lander, but indirectly a great benefit to the yield at Laramie.

Preparing Seed:—The yield obtained from small potatoes planted whole has been greater than from large potatoes cut, but the percent of marketable tubers has been less from the whole or small seed.

Of the different methods of cutting the seed, that of quartering the tuber lengthwise and leaving part of the seed end on each piece gave the best results.

The rate of seeding per acre that proved best in each case was that amount which placed the sets eight inches apart in the row. Planting both closer and farther apart gave lower yields.

Potatoes at Different Altitudes:—The time between planting and harvesting the crop is almost identical at the differ-

ent altitudes in the state. Contrary to the general opinion the range of temperature is greater at lower altitudes than at higher.

The altitude apparently does not affect the yield.

The average specific gravity of the varieties grown at Sundance was 1.096 and at Laramie 1.081, during the season of 1896.

Planting, Cultivation, and Irrigation:—In the operations of planting precautions should be taken to conserve the soil moisture by preventing evaporation in every way possible.

High cultivation should be given, and the soil should be prevented from baking by cultivation between irrigations when possible. Too early irrigation should be avoided.

Yields, Cost and Profit:—The average yield for the state is from 100 to 150 bushels per acre. The largest authentic yield in the state is 974 bushels and 48 pounds.

The average net profit per acre, from fifty varieties, for three years, at Laramie is $31.15.

The average net profit per acre for two years at Lander is $52.10.

The net profit per acre at Sundance for one year is $37.50.

The average net profit per acre at Wheatland for three years is $19.10.

The best keeper of all the varieties grown is the Blue Victor. In this respect it cannot easily be excelled.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING,

BULLETIN NO. 33.

JUNE, 1897.

The Composition of Prepared Cereal Foods.

BY THE CHEMIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

—(6)

From.
F. P. Graves
Univ. of Wyoming.

Wyoming Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

PRESIDENT OF THE UNIVERSITY OF WYOMING.

FRANK PIERREPONT GRAVES, A. M., Ph. D., LL. D.

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The Composition of Prepared Cereal Foods.

E. E. SLOSSON.

The introduction and extended use of the prepared cereal foods, ordinarily classed as "breakfast foods," amount to a veritable revolution in the food habits of the nation. Not many years ago the only foods of this character in use were hominy, rice and, later, cracked wheat. Oatmeal was almost unknown. Now, however, a great variety of cereal foods is in common use in almost all parts of the country and the market is flooded with package preparations of wheat, oats and corn, rivalling each other in ornateness of wrapper, novelty of name and ingenuity in advertising. The first foods of this character to be introduced were poorly prepared and required a long time and considerable skill to properly cook them but improved methods of milling have now produced many excellent cereal foods prepared for the table and already partly cooked. On account of the extravagance of the claims made for these foods and the wide difference in character and price it seemed desirable that some analyses should be made to show their real and relative value. Accordingly samples of all the prepared cereal foods to be found in Cheyenne and Laramie were purchased and analyzed with the results given in Tables I. and II.

EXPLANATION OF TERMS.

As this is the first bulletin issued from the Wyoming Experiment Station on the subject of foods a popular explanation of the meaning of the technical terms used and some discussion of the relative value of food constituents may be necessary.

Food is used in the body for two purposes, to supply the waste of the materials of which it is composed

and to supply the necessary energy for its operations and movements. To meet these two requirements by food which shall be of agreeable flavor and not excessive in quantity or cost is the unconscious object of our choice of food. The three most important constituents of food are protein, carbohydrates and fats.

Protein differs from the other two classes in that it contains nitrogen, one of the essential elements of the human body, which can only be obtained in this form. The proteid compounds are often called albuminoids and form the principal part of lean meat and egg albumen. If one chews a mouthful of wheat for some time without swallowing it there will be left a gummy mass known as gluten, the most important form of protein in grains. Protein is the most expensive of the constitutents of food.

The carbohydrates include what we know as starches and sugars. They contain no nitrogen so cannot enter into the composition of the muscles of the body but they have about the same value as sources of energy as protein and,being the cheapest food, they constitute the principal part of our diet. The carbohydrates of cereals are mostly in the form of small hard starch grains which are not easily attacked by the digestive fluids. By cooking these grains are broken into powder and the starch is partly changed into the more soluble and digestible forms of dextrin and glucose. In prepared cereal foods the starch grains have been crushed and partly converted into soluble forms by means of heat, pressure and moisture, thus lessening the time needed for cooking. The amount of these soluble starches and sugars has been determined by dissolving them in cold water and is reported in a separate column from the carbohydrates insoluble in cold water. Fiber is the woody portion of the grain. It is entirely indigestible by man and is therefore separated from the nutritious carbohydrates, the sugars and starches. Although it is of no food value yet it is not ob-

jectionable in the small quantity found in prepared cereals and it is not certain that it would be of advantage to free food absolutely from indigestible matter.

Fats, under which term are included all the oily matter of the grains, are similar in composition to carbohydrates but are a more concentrated form of food since they give two and a half times as much energy to the body as the carbohydrates and protein.

The mineral or earthy matter of food is reported under the name of "ash" or the incombustible portion of the grain. It includes a large number of elements such as potash, soda, lime, magnesia, sulphur and chlorine which are necessary for both bone and flesh but as there is usually no deficiency in any of these the analysis need not be carried further. Phosphorus, which is partly included in the ash, is an element of such importance that special efforts are made in milling to secure it. It forms seventeen per cent of the mineral matter of the bones and the body of a man contains about a pound and a quarter of it.

The water in foods of course is of no value, but to make food absolutely dry would be both expensive and undesirable. As the percent of water is so variable it is difficult to see the relative values of different foods by comparing the percent given in the complete analysis. For that reason the analytical results have been calculated to a water-free basis in Table II.

Fuel Value.—The compounds of hydrogen and carbon, which form most of our food, are transformed by their use in the body into carbonic acid and water just as they are by burning in air, consequently the same amount of energy in the form of heat or labor is obtained from them by using as fuel in a stove or as food in the body. The chief use of food is to supply energy to our bodies for warmth and work and the amount of energy to be obtained from any kind of food can easily be determined by burning a sample of it un-

der such conditions that the amount of heat produced can be measured accurately. Nitrogenous foods are not consumed so completely in the body as by burning and therefore do not give quite so much energy but the difference is known and can be allowed for.

METHODS OF ANALYSIS.

The methods used in these analyses are those adopted by the Association of Official Agricultural Chemists with the few variations here noted. All determinations were made in duplicate except some of the ash, phosphorus and fuel value estimations. Air was used as a drying medium instead of hydrogen. The determination of water-soluble carbohydrates was made to estimate the amount of previous preparation or cooking the food had undergone. After a good deal of experimenting the following method was adopted which is rapid and sufficiently accurate for the purpose. Ten grains of the food were treated with 100cc of cold water in a stoppered wide-mouthed bottle, allowed to stand with occasional shaking for twelve hours and then for twelve hours without shaking, filtered through a folded filter and measured. To this solution which amounts to 50 or 80cc and usually gives a purple reaction with iodine, ten per cent of its volume of hydrochloric acid is added and it is heated on a boiling water bath (at a temperature of 93 degrees here) for two hours. Then it is neutralized, measured and the determination made with Fehling's solution. In this way a solution of the proper strength is obtained with evaporation. Duplicates made at different times agree to one-tenth per cent. The fuel values were determined by combustion in Mahler's bomb calorimeter. A description of the apparatus and the determination of its water value may be found in a special bulletin on "The Heating Value of Wyoming Coal and Oil," published by the University of Wyoming in January, 1895. Readings were made with a tele-

scope to one-thousandth of a degree. The oxygen was passed through a red hot tube to prevent traces of oil being carried over from the pump.* The fuel value as determined by the calorimeter is almost always a little higher (one to five per cent) than that calculated from the composition by the use of Stohmann's factors,† 4.2 for starch and cellulose, 9.5 for fats and 5.7 for protein. The factors for carbohydrates since they are of known substances easily extracted are probably correct and constant, that for fats is less so, while the factor for protein is based on very insufficient evidence and is undoubtedly wrong in some cases. With such foods as these it is probably too low, as 5.9 gives better results, but our knowledge of the proteids is too incomplete and our method of determining them too inexact to decide upon a constant, if such were possible. Calorimetric determinations are now exact enough to afford some guide to composition.

*Stohmann, Kleber und Langbein, Journal für praktische Chemie, *39*, 513.

†Zeitschrift für physikalische chemie, *10*, 410, and *6*, 334. Experiment Station Record, *6*, 590.

TABLE I.—*Composition of Prepared Cereal Foods as Purchased.*

No.	NAME.	Water, per cent.	Fat, per cent.	Protein, per cent.	Carbohydrates. Total per cent.	Carbohydrates. Soluble in water, per cent.	Carbohydrates. Insoluble in water, per cent.	Carbohydrates. Fiber, per cent.	Ash, per cent.	Phosphorus, per cent.	Fuel Value, calories per gram.	Price per pound, cents.
	WHEAT.											
1	Wheatena	6.65	2.28	14.17	75.62	3.9	70.50	1.22	1.28	.363	4343	14.2
3	Wheat Manna	9.65	1.49	16.60	70.71	3.5	65.91	1.30	1.55	.347	4203	8.9
6	Pettijohn's Breakfast Food	9.51	1.45	10.56	76.96	2.8	72.15	2.01	1.52	.231	4174	7.6
7	Farinose	6.34	3.72	14.71	73.78	4.0	68.34	1.44	1.45	.288	4437	10.3
8	Farina	10.94	1.56	10.90	75.91	3.2	72.12	.59	.69	.153	4051	15.8
9	Cracked Wheat	9.30	2.22	12.60	94.42	3.3	69.63	1.49	1.46	.333	4236	7.6
10	Germade	9.52	2.07	9.37	77.38	3.2	73.62	.56	1.66	.168	4100	7.0
13	Wheatlets	10.04	1.75	10.40	76.24	1.4	73.26	1.58	1.57	.357	4689	4.3
14	Sioux Wheat Flakes	8.88	1.49	10.80	77.23	3.8	71.80	1.63	1.60	.311	4181	7.6
16	Ralston Breakfast Food	9.72	1.90	15.10	71.75	4.6	65.60	1.55	1.53	.343	4158	11.2
17	Durkee's Glutena Food	8.77	1.20	13.60	75.71	2.7	72.46	.55	.72	.251	4176	13.2
18	Fould's Wheat Germ Food	10.13	1.46	13.30	73.93	3.7	69.35	.88	1.18	.326	4087	7.7
19	Golden Sheaf Wheat Flakes	9.38	1.43	9.68	77.82	4.3	71.34	2.18	1.69	.395	3993	8.2
	OATS.											
4	Quaker	7.40	6.08	17.20	66.65	1.6	64.65	1.40	1.67	.341	4673	7.9
5	Hornby's	7.63	7.35	17.82	65.47	1.3	62.74	1.43	1.73	.443	4756	12.8
11	Cormack's Nudavene	6.56	6.36	17.55	67.78	2.9	63.56	1.32	1.75	.445	4617	5.0
12	Buckeye	7.54	8.30	16.89	65.55	3.3	60.90	1.35	1.72	.416	4526	4.9
15	Bulk	8.07	6.52	17.74	65.89	2.5	62.40	.99	1.78	.414	4665	2.5
20	Douglas & Stuart	8.04	6.63	17.08	66.43	3.6	61.66	1.17	1.82	.447	4475	4.9
	CORN.											
2	Cerealine	9.55	1.24	9.90	78.75	7.1	70.93	.72	.56	.192	4542	9.2
21	Velvet Meal	9.80	2.32	6.75	80.53	1.8	77.77	.96	.60	.185	3660	4.1

TABLE II.—*Composition of Prepared Cereal Foods Calculated as Water-Free.*

No.	NAME.	Fat, per cent.	Protein, per cent.	Carbohydrates. Total per cent.	Carbohydrates. Soluble in water, per cent.	Carbohydrates. Insoluble in water, per cent.	Carbohydrates. Fiber, per cent.	Ash, per cent.	Phosphorus, per cent.	Fuel Value, calories per gram.	Price per pound, cents.
	WHEAT.										
1	Wheatena	2.44	15.18	81.01	4.2	75.50	1.31	1.37	.389	4652	15.2
3	Wheat Manna	1.65	18.37	78.26	3.9	72.92	1.44	1.72	.384	4652	9.9
6	Pettijohn's Breakfast Food	1.60	11.67	85.05	3.1	79.73	2.22	1.68	.255	4613	8.4
7	Farinose	3.97	15.71	78.77	4.3	72.93	1.54	1.55	.306	4737	10.9
8	Farina	1.75	12.24	85.24	3.6	80.97	.67	.77	.172	4549	17.7
9	Cracked Wheat	2.45	13.89	82.05	3.6	76.81	1.64	1.61	.367	4670	8.3
10	Germade	2.29	10.36	85.52	3.5	81.40	.62	1.83	.186	4531	7.7
13	Wheatlets	1.94	11.56	84.75	1.6	81.39	1.76	1.75	.397	5212	4.7
14	Sioux Wheat Flakes	1.64	11.85	84.76	4.2	84.73	1.79	1.75	.341	4588	8.3
16	Ralston Breakfast Food	2.10	16.73	79.48	5.1	72.66	1.72	1.69	.380	4494	12.4
17	Durkee's Glutena Food	1.32	14.91	82.99	3.0	79.38	.60	.79	.275	4577	14.5
18	Fould's Wheat Germ Food	1.63	14.80	82.26	4.1	77.18	.98	1.31	.363	4547	8.5
19	Golden Sheaf Wheat Flakes	1.58	10.68	85.88	4.7	78.76	2.41	1.86	.436	4420	9.1
	OATS.										
4	Quaker	6.57	18.57	75.06	1.7	69.85	1.51	1.80	.368	5046	8.5
5	Hornby's	7.96	19.28	70.88	1.4	67.93	1.55	1.87	.479	5148	13.8
11	Cormack's Nudavene	6.81	18.77	72.54	3.1	68.03	1.41	1.88	.476	4941	5.4
12	Buckeye	8.98	18.27	70.89	3.6	65.83	1.46	1.86	.450	4895	5.3
15	Bulk	7.09	19.31	71.67	2.7	67.90	1.07	1.93	.450	5074	2.6
20	Douglas & Stuart	7.21	18.57	72.24	3.9	67.07	1.27	1.98	.486	4866	5.3
	CORN.										
2	Cerealine	1.37	10.95	87.06	7.9	78.37	.79	.62	.212	5021	10.2
21	Velvet Meal	2.57	7.48	89.28	2.0	86.22	1.06	.67	.205	4390	4.5

Description of the Foods.

The names of the foods analyzed and of the manufacturers are given below together with quotations from the advertisements setting forth the special claims of the preparations. The price given is the cost of a single package in Laramie or Cheyenne. When different stores charge different prices, as is frequently the case, the lowest price is taken.

No. 1. Wheatena, manufactured by Health Food Co., N. Y. "Made from white wheat, the bran coats are removed and by a peculiar process the starch is converted into a soluble substance. Can be perfectly prepared for the stomach by simply adding it to boiling water or to cold or hot milk without any cooking whatever. Rich in phosphatic elements, abundant in nitrogen, deficient in starch."

Size of package 4x3x5¾. Price 30 cents. Weight of contents 32.5 ounces.

No. 2. Cerealine Flakes. Cerealine Manufacturing Co., Columbus, O. "Prepared from pure white maize. Will cook in one minute." Package 5½x8½x5½. Price 15 cents. Weight of contents 25.8 ounces.

No. 3. Wheat Manna. Centennial Mills, Spokane, Wash. "From the choicest white wheat; hulls removed, leaving pure white berry; easily digested; cook ten minutes."

Package 8x4⅝x4⅝. Price 15 cents. Weight of contents 26.8 ounces.

No. 4. Quaker Rolled White Oats. American Cereal Co., Chicago. "Owing to our peculiar methods of manufacture we do not sacrifice the sweetness and flavor of the oat for the sake of rapid cooking." "Boil twenty minutes or more."

Package 4x4x8 inches. Price 15 cents. Weight of contents 30.6 ounces.

No. 5. Hornby's steam-cooked three-minues Oatmeal. Manufactured by the Clover Mills, Buffalo, N. Y. "Analysis prove these Oats to possess a larger proportion of brain and muscle producing elements than any vegetable, flesh or other cereal food now used by man." "Analysis, Nitrates, 19.39, Carbohydrates 73.27, Phosphates 3.34, Water 4.00."

Package 3½x3x7½ inches. Price 25 cents. Weight of contents 31.2 ounces.

No. 6. Pettijohn's California Breakfast Food. American Cereal Co., Chicago. "From wheat, hulls carefully removed, leaving nutritious and no irritating parts." "Boil fifteen minutes or more."

Package 4½x4½x8 inches. 15 cents. Weight of contents 31.4 ounces.

No. 7. F. S. Parched Farinose. American Cereal Co., at F. Schumacher Mills, Akron, O. "Made from the best amber wheat, all nitrates, gluten and phosphates retained."

Package 2½x4x7 inches. 20 cents. Weight of contents 30 ounces.

No. 8. F. S. Pure Wheat Farinose. American Cereal Co., at F. Shumacher Mills, Akron, O. "Made from the most nutritious parts of wheat and is rich in gluten, nitrates and other properties necessary for the nourishment of the muscles, nerves and bones." "Boil ten minutes."

Package 1½x3x6 inches. 15 cents. Weight of contents 15.1 ounces.

No. 9. F. S. Cracked Wheat. American Cereal Co., at F. Schumacher Mills, Akron, Ohio. "Woody fiber and silex thoroughly removed." "Boil one to two hours."

Package 4x2½x7 inches. 15 cents. Weight of contents 31.4 ounces.

No. 10. Thatcher's Germade. Thatcher Milling and Elevator Co., Logan, Utah. "From Cache Valley White Wheat." "It contains more nutriment than any other article of food known." "Cooks in a few minutes."

Package 4x4x8½ inches. 25 cents. Weight of contents 54.2 ounces.

No. 11. Cormack's Patent Process Nudavene Flakes. American Cereal Co., Chicago. "Made from pure northern white oats, superior to any other oat product." "Cook in twenty minutes."

Package 4x4x8 inches. 10 cents. Weight of contents 31.8 ounces.

No. 12. Buckeye Rolled Oats. American Cereal Co., Chicago. "It is rich in nutritious quantities. Cooks in twenty minutes."

Package 4x4½x8 inches. 10 cents. Weight of contents 32 ounces.

No. 13. Wheatlets. Lindell Flour Mills, Ft. Collins, Colo. "Five-pound sack." 20 cents. Weight of contents 74.4 ounces.

No. 14. Sioux Wheat Flakes. Sioux Milling Co., Sioux City, Ia. "Made from California White Wheat." "Cook fifteen to 20 minutes."

Package 8x5x4 inches. 15 cents. Weight of contents 31 ounces.

No. 15. Oatmeal sold in bulk, Laramie. American Cereal Co. Ten pounds for 25 cents.

No. 16. Ralston Health Club Breakfast Food. Purina Millls, St. Louis, Mo. "The Ralston Health Club in analyzing the various breakfast foods on the market found one that proved to be the only perfect and by far the most healthful breakfast food in the country." "Cooks in five minutes."

Package 5x2¼x7. 20 cents. Weight of contents, 31.6 ounces.

No. 17. Durkee's Glutena Food. E. R. Durkee & Co., N. Y. "Of the various elements composing wheat, the nitrates, viz.,gluten and fiber,form about 15 per cent, the phosphates 2 per cent, the remainder consists of about 70 per cent of carbonate of starch and about 13 per cent of water." "Glutena consists entirely of the gluten and phosphates of wheat." "Boil ten minutes."

Package 3¼x2x6. 15 cents. Weight of contents 18 ounces.

No. 18. Fould's Wheat Germ Meal. Daverio Process. Fould's Milling Co., Cincinnati. "It contains the best and most nutritious parts of the wheat."

Package 4x2½x7. 15 cents. Weight of contents 30.1 ounces.

No. 19. Golden Sheaf Wheat Flakes. Sprague Warner & Co., Chicago. "A healthy stimulant to nerve and brain forces as indigestible properties in the wheat are entirely removed."

Package 8x4½x4½. 15 cents. Weight of contents 28.9 ounces.

No. 20. Douglas and Stuart's Rolled Oats. American Flaked Oat Groats. American Cereal Co., Chicago. "Superior to any farinaceous goods in this line." "Partly cooked."

Package 5x3x8, 10 cents. Weight of contents 32. 4 ounces.

No. 21. Velvet Meal, Quail Brand. Nebraska City Cereal Mills, Nebraska City Neb. "One pound of properly prepared corn meal is more than equivalent to two pounds of fat meat."

Package 4x3½x7, 10 cents. Weight of contents 38.8 ounces.

Discussion of Results.

The chemical analyses and examination of the starch grains with the microscope showed no evidence of the presence of foreign cereals, so adulteration may be regarded as absent in foods of this class.

The packages are generally short weight but only in a few cases was there such a discrepancy between the actual weight of contents and that marked on the wrapper as to indicate an intentional fraud.

Leaving aside the customary claims of each food to be the best in the market and considering only the more specific statements of composition, food value, etc., it may be said that these are in many instances entirely unreliable and misleading as to the real character of the food. When the general public becomes better educated on the subject of foods we may expect advertising to take the form it already has taken in many other industries, that of an attractive and intelligent presentation of the real merits of the article. If purchasers of goods in packages and cans would always note the brand and afterwards buy according to the quality, it would be a good encouragement to honest manufacturers and the grade of such foods would no doubt be raised. The chief advantages of package goods is that the manufacturer is made directly responsible to the consumer.

It will be seen that there is more variation in price than in composition, and that there is no discoverable relation between quality and price. Some articles are four or five times the cost of others of the same class and apparently of the same merit. It is quite evident who pays for the beautiful advertisements that form the bulk of our magazines. At the same time it is not the most extensively advertised foods that are the dearest. The oatmeal sold in bulk is practically

the same in composition and, so far as can be judged by personal taste, in quality and flavor as that sold in packages for several times the price. Of course in buying bulk articles one is not so sure of getting the same grade or that the quality has not been injured by long keeping and exposure.

The claims made for quick cooking are generally fallacious. Almost all such preparations should be cooked for at least half an hour and usually longer to insure the complete digestibility of the starch. Except in the case of corn the addition of milk or cream is not needed to supply any deficiency in the foods. Sugar should be used only as a condiment. Most people in the United States eat so much sugar as to quite unbalance a ration already excessive in carbohydrates.

The question that will probably be asked by most people who read this bulletin "Which is the best food?" is one that cannot be answered. There is no "best food." The three grains used have each distinctive and useful qualities. Oatmeal contains more of the valuable ingredients, protein and fat, than the other two and approaches closely in composition to a correctly balanced food. These facts do not, however, exclude the use of wheat and corn preparations which are to many preferable. All that such a bulletin as this can do is to give the data on which the judgment of the reader can form his own estimates of the relative merits of the foods analyized. Human food is generally selected on account of flavor and this as a question of taste is outside the bounds of discussion. The important question of digestibility and wholesomeness is also one which every man must settle with his own stomach. The older investigations on this subject are quite misleading. Not every man has a stomach like Alexis St. Martin's or Brown-Sequard's, still less like a test tube in a water bath. Recent experiments are giving more reliable results but individual differences are so important that the choice of food cannot be ultimately

decided by the application of general principles. About 85 per cent of the protein, 90 per cent of the fat and 98 per cent of the carbohydrates in cereals are digestible.* Composition cannot be taken as a perfect guide to the real value of a food. One series of experiments on the digestibility of whole wheat flour and fine flour showed that a less amount of the valuable constituents was digested from the whole wheat than from the fine flour although the former was superior in composition.† The popular articles in the newspapers on dietics are for the most part misleading, either because they are premature judgments based on insufficient data or because they are written in favor of some food fad. Those interested in the subject may get reliable information from the bulletins of the Department of Agriculture at Washington and reports of experiment stations and kitchens. [Farmer's Bulletin No. 23 on "Foods, Nutritive Value and Cost," Farmer's Bulletin No. 34 on "Meats; Composition and Cooking." Bulletin No. 24, Office of Experiment Stations on "Chemistry of Food." Also magazine articles by Prof. Atwater and others as in the Century for June, 1897.]

*Report of Storrs Agricultural Experiment Station, 1896, p. 188.

†Chemie der menschlichen Nahrungs- und Genussmittel, Koenig, Vol. I. p. 43.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING,

BULLETIN NO. 34.

NOVEMBER, 1897.

Fruit Growing in Wyoming.

BY THE HORTICULTURIST.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

Wyoming Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

President of the University of Wyoming.

FRANK PIERREPONT GRAVES, Ph. D., Litt. D., LL. D.

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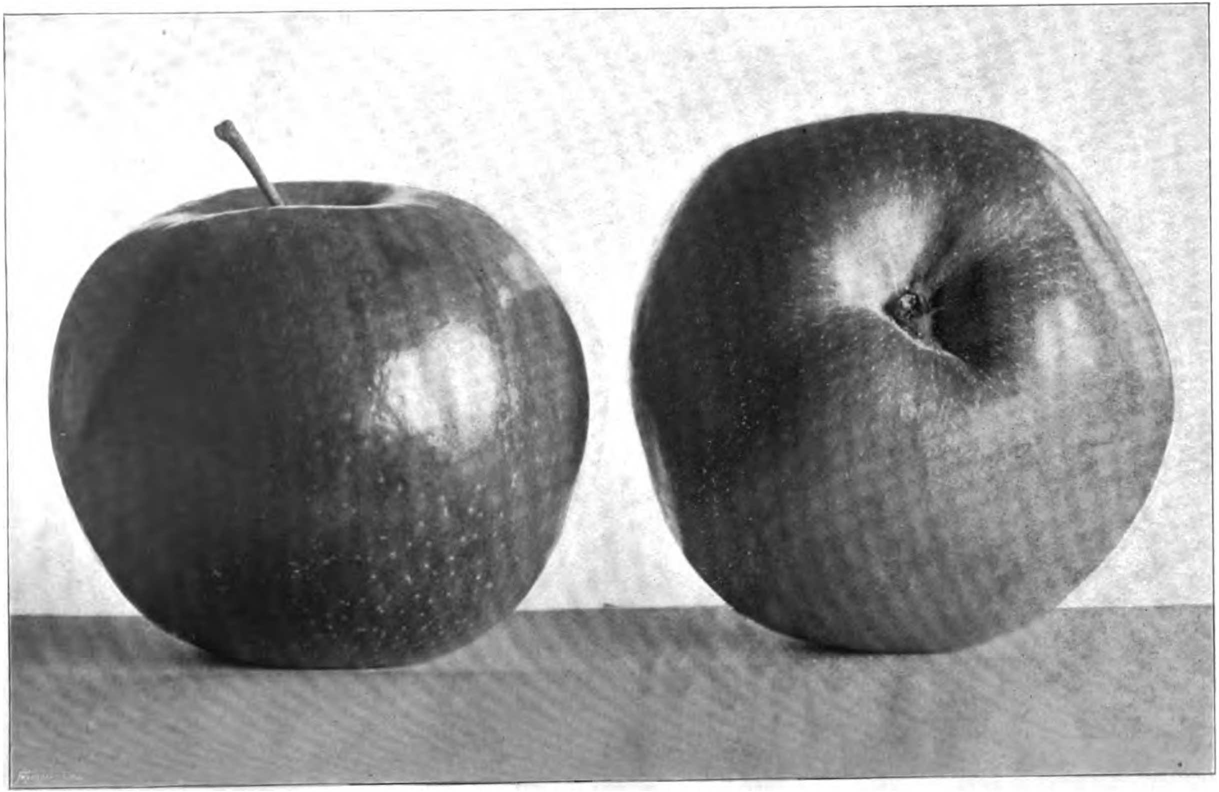


WEALTHY APPLES, Natural Size   Raised by J. Lund, Laramie, 1897.

Fruit Growing in Wyoming.

B. C. BUFFUM.

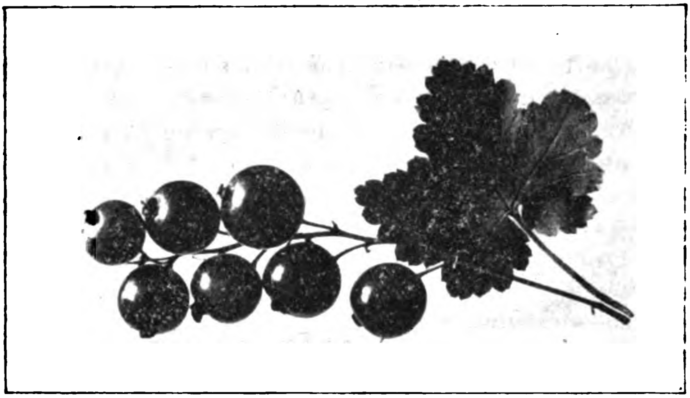
This bulletin is issued to report the results of the experiments with fruits which have been in progress upon the experiment farms since the first plantings in the spring of 1892. The experiments planned were practically the same for each of the experiment farms, although the plantings were somewhat less extensive upon the farms where the conditions were known to be less favorable. The fruit investigations have been given varying amounts of attention upon each farm. This has been due to several causes, among which may be mentioned the more or less favorable conditions, the newness and importance of other agricultural investigations, local accidents to small fruits or orchards, and the personal taste of each superintendent. Where accidents occurred to destroy a strawberry bed or part of an orchard, and lack of funds prevented replacing them at once, the experiments were delayed. It is largely due to this fact that it is impossible to report experiments with different classes of small fruits upon some of the farms. The length of time has not been sufficient since planting orchards to draw definite conclusions. Some of the trees are beginning to bear fruit and indicate in a general way what may be expected of tree fruits. Farmers can safely plant those varieties which have fruited in their section of the state. No doubt other varieties will succeed, but until they have been tested, planting will be a matter of experiment.

Horticultural operations in Wyoming are still new. Therefore up to the present time we have merely attempted to demonstrate whether or not certain fruits could be raised in the different sections of the state. We believed that they could be, but it had not been demonstrated. Before the Experiment Station was established, perhaps half a dozen farmers in different sections had some fruit planted. In 1892 the most liberal estimates from different counties placed the total amount of land in the state planted to fruit at less than 85 acres, and there was probably not more than half that amount. It is very doubtful if the total amount now will exceed one hundred acres of land actually planted to fruits of any kind in the whole state, and certainly the estimate is large enough if we confine it to orchard or other fruits which are in bearing. There has been, however, a change of heart in regard to all branches of agriculture in the last few years. The state is rapidly settling up and many are evincing great interest in the possibility of fruit raising.

As a matter of history, as well as to demonstrate what can be done along this line, we have, in addition to our own experiments, attempted to represent all the fruit growers in the state. We have been unable to visit or get reports from Uinta county, and it is probable there are some fruit growers there that we have been unable to represent. So far as we could get statements from growers of the state, or from their neighbors, they are given in the bulletin. The cultural directions given and notes on irrigation are only such as apply to our own conditions. No attempt has been made to write exhaustively upon the subject, but it is hoped that such information as is given will be of benefit to those who may wish to grow fruits and to new comers to the state who are unacquainted with our conditions. It is hoped also that the bulletin will demonstrate to those who are looking for homes in the West the fact that Wyoming has agricultu-

ral and horticultural possibilities of her own. The traveler who crosses our state on any of the railroad lines sees little agricultural development and is apt to conclude that our plains and mountains are only pastures for cattle, horses, and sheep. If this bulletin stimulates a part of our people who have homes, to better their conditions, by supplying themselves with the luxury of fresh, health-giving fruits from their own gardens, elevating the tone of their living, and at the same time reducing its cost, we shall feel that the labor and expense are insignificant.

Our illustrations are all half-tones from photographs, except the one of a fruiting branch of the Japanese Wineberry. Unless otherwise stated under each, the illustrations are from fruits grown upon the Experiment Station farms. Thanks are due to all those who have generously assisted in the preparation of this report. W. H. Fairfield has aided the writer in the preparation of the subject matter, more especially with the cultural suggestions and tabulations. Hon. J. M. Carey has kindly loaned three of the engravings and furnished data. J. H. Gordon, J. Lund, and J. King furnished fruits from which photographs were made, and G. W. Barlow and C. H. Manning furnished data and three of the photographs. Thanks are due the superintendents of all the farms, and especially J. S. Meyer of Lander, for his untiring energy and kindness in furnishing information regarding his own orchard work.



Red Cherry Currant, Natural Size.

CULTURAL SUGGESTIONS.

The general laws of cultivation of fruits are the same everywhere, but in the arid region, methods of planting and treatment differ materially from those in general practice where irrigation is unnecessary. Those methods which produce best results in adjoining arid states will be found applicable to our conditions, varying somewhat with the locality, soil, exposure, climatic conditions, and water supply. No class of crops will give greater or more satisfactory returns for attention and care bestowed, than fruits. They naturally require intensive cultivation. The most of them have been domesticated for a great many years. They have been nursed and improved to reach their present perfection, and are so far above the wild sorts that they more quickly succumb when neglected. They have been cared for so long that they have lost much of the power of competing with other plants in the struggle for existence. This is undoubtedly intensified when they are brought into conditions differing from those of their original home.

They adapt themselves rather slowly to new conditions, and on this account we believe it always pays to patronize

good reliable home nurserymen who have stock raised under like conditions and more or less acclimated, than to buy plants from a distance where they are raised under widely differing conditions. This was illustrated in the sudden storm of September, 1895, which killed nearly all the young trees in the orchards of the state, while only a small percent of the old well-established and acclimated trees died from its effects. Another evidence is that nearly all the strawberry plants which were pot-grown in the east died when set out upon the experiment farms, while a large per cent of hardy out-door plants from western nurseries lived.

While we know of one or two orchards in the state where trees were purchased in the east, we believe our recommendation to plant only western grown trees, or western stock of any fruit a good one, provided that the stock is as good and the varieties wanted can be obtained.

The soils of the state are, as a rule, quite rich in the inorganic plant foods, principally lacking in humus or vegetable mold which supplies nitrogen. However, it will probably be found advantageous to supply fruits, more especially orchards, with some fertilizer rich in potash. Wood ashes will answer the purpose well, where they can be obtained. Barnyard manure is the most perfect fertilizer and should always be used liberally with fruits. Insect enemies of fruits have not yet been reported as doing damage in this state, with the exception of the Codlin Moth, which has made its appearance at Lander. If concerted action is taken, the spread and increase of injurious insects could be largely, if not entirely, prevented. It is important, then, that every one should destroy such pests as soon as they appear. Modern methods of combating these insects by spraying, etc., directions for which are given in recent horticultural publications, should be carefully followed.*

*Anyone desiring information in regard to methods of spraying, and solutions with which to combat insect enemies or plant diseases, is invited to write to the Horticulturist, Experiment Station, Laramie, Wyoming.

The following brief cultural directions we believe will be found applicable to most parts of the state.

THE ORCHARD.

Deciding on the location of an orchard is an important step. Under our conditions a north slope is preferable, because the snow stays better in the winter, the buds are not apt to start so early in the spring, and the trees are not so liable to become burned on the south and west sides by the bright sunshine during the time that there are no leaves on them. We prefer a well-drained soil, along a stream, with all the protection which can be obtained from surrounding trees, hills, or buildings, especially on the sides from which the prevailing winds blow. The soil in such a locality is not apt to contain enough alkali to be injurious, and where winter irrigation can not be practiced, the bottom lands are not so apt to freeze and thaw often, or dry out. When given proper care, however, orchards will succeed well on uplands. Plant windbreaks of cottonwoods and willows on the side or sides from which the prevailing winds blow.

The soil should be thoroughly prepared, manured, plowed, and if possible, subsoiled, and harrowed. It is generally better to set the trees in rows both ways, but on steep slopes it is sometimes necessary to plant one way, following the contour lines, so that the land may be irrigated without washing. We recommend buying trees in the fall, heeling them in over winter and planting in the spring. Heel them in in a place where the soil is not apt to dry out or blow away, and cover roots,stems,and branches with soil. Lay the trees well apart, for if they are placed in bunches, open spaces are apt to be left among the roots and stems, harboring mice or other rodents, which gnaw the roots and bark, either greatly injuring or entirely destroying the trees. A number of trees were destroyed in this way at Lander.

There is some diversity of opinion as to the distance apart trees should be planted under our conditions.. Some claim that many orchards are running out in the West before they should, because the trees are set too close together. We think good distances are twenty-five feet each way for apples, eighteen or twenty feet for crabs and pears, twelve or fifteen feet for cherries and plums. The branches should not be allowed to touch or interlock when the trees are full grown.

In digging holes in which to set trees, make them large enough to accommodate the roots without twisting or bending them. If hard-pan is reached, it should be broken up around where the tree is to be set, using blasting powder, if necessary. Set trees the same depth in the ground as they were in the nursery rows. We think the surest way to make trees grow is to cut back the tops judiciously, place enough loose soil in the hole to cover the roots and hold them in place, working it in around them closely, and then fill the hole with water. After the water has soaked away sufficiently, finish filling the hole even with the ground, tramping it firmly around the trunk. Planting with water in this way is generally better than puddling the soil, which is apt to be injurious if the soil contains much clay.

The best age to set out is probably two years from the graft. We like trees which are headed low, i. e. from two to three feet from the ground. In starting the head with young trees, avoid making crotches or pruning too much. Pruning is always in order. The sooner limbs or branches which are not wanted are cut off, the less strength they will take from the tree.

We have seen some fruit and shade trees so disgracefully pruned, that it calls for a word of protest here. In amputating the limb of a man, it may be wise to take it off as far from the trunk as possible, but in pruning trees,

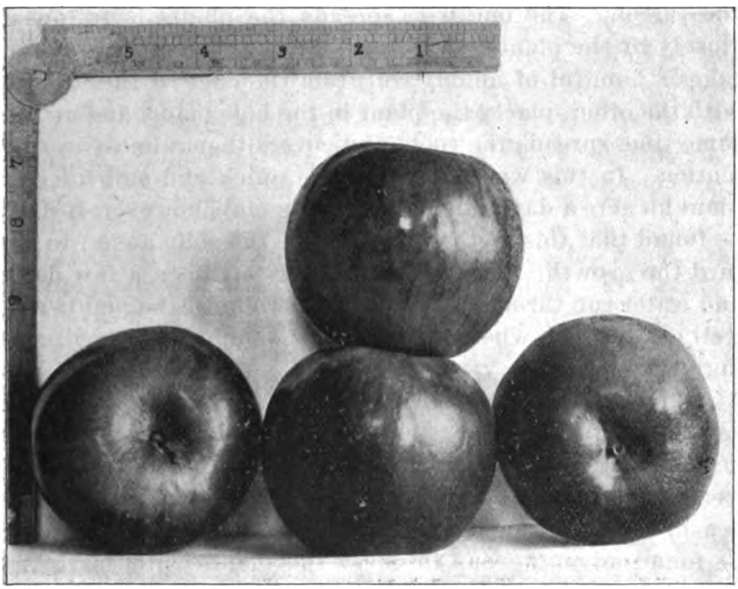
—(o)

always pursue exactly the opposite policy. Many make a practice of cutting off limbs two or four inches from the trunk or main branch, which makes stubs that die and leave behind a diseased place or ugly scar. Whenever a branch or limb is removed, it should be cut off as close to the trunk or branch upon which it groes as possible, making a smooth cut over which the bark will grow and heal the wound. In cutting back the tops of trees, we prefer to make slanting cuts with a sharp knife or ax rather than sawing the limb squarely off. In cutting back top limbs, cut off jus above a bud or limb, so there will be little or none of the branch left which will die below the cut. Any severe pruning of the apple should be done in the spring before the buds swell. Cherries and plums should be pruned in the summer, for, if they are cut at other seasons, gum exudes from the wounds. Summer pruning should never be severe, but should consist in rubbing off buds which are developing where they are not wanted, and pinching back slender limbs to increase fruitfulness and make a well formed tree.

Give the orchard clean cultivation. Never allow weeds to grow and give the surface of the soil a shallow cultivation often. We do not recommend planting any kind of grass in the orchard. If crops are raised on the land between young trees, they should be planted some distance from them and should consist of some hoed crops which require shallow cultivation and do not grow tall enough to shade the trees. Good crops for this purpose are beans, peas, squashes, pumpkins, and melons. Rows of currants and gooseberries may be planted between the apple rows, but such fruits as raspberries are not so good, as they grow tall and require so much digging for their winter protection that the roots of the trees are apt to be injured.

It pays to give trees winter protection. Place a good heavy mulch of barnyard litter around each tree, taking care

not to let it come directly against the trunk, to heat or harbor insects or mice which will injure the bark. Our jack rabbit is also fond of gnawing the bark of trees. Shoot the rabbit, and protect the trees with some mechanical device such as wire screen, or better still, some form of slat protectors. It is better to place the mulch around the trees after the first snow storm, as it will hold the moisture and guard somewhat against alternate thawing and freezing. Wrapping the trunks of the trees with burlap and then with paper, tied on securely, will prevent their sunburning and largely check the transpiration of moisture. A board, or better, two boards nailed together, forming a right angle, and set on the south and west of each tree, will keep the trunk from becoming sunburned.



Wealthy Apples, Laramie, 1897. Raised by J. Lund.

SMALL FRUITS.

STRAWBERRIES.—New beds may be planted either in the spring or late summer. If planted in late summer or fall, do it as early as good thrifty young plants can be obtained for the purpose. Strawberries are of easy culture and will grow almost anywhere, but they well repay every advantage given them. Have the soil well manured and thoroughly pulverized. Plow the manure into the soil six months or a year before the plants are set, and have the land as free from weeds as possible. Set the plants in rows three or four feet apart and place them one foot apart in the row. The quickest and surest way to plant is to plow straight, narrow furrows for the rows, run water enough through the furrows to soak them up well, and have the plants dropped the proper distance apart along the edge of the furrow. The one who spreads the plants is followed closely by the planter, who takes up the plant in one hand, takes a handful of muddy soil from the edge of the furrow with the other, places the plant in the hole made, and at the same time spreads the roots and covers them almost in one motion. In this way a man who is quick and skillful can plant an acre a day and do it well. In clay, however, it may be found that this method will puddle the soil enough to retard the growth. The furrows can be left open a few days and water run through every day or two until the plants are well established, when a new furrow should be plowed, filling up the old one.

Give the plants careful attention the first season. Irrigate in the fall, and as soon as the ground is frozen, mulch heavily with clean straw or other litter that is as free from weed seeds as possible. Hold the mulch in place with poles, brush, or other weights. In some parts of the state it may be found advantageous to cover the plants with earth instead of other mulch. Sometimes a light mulch of pine needles or straw is left around the plants in the spring

to keep the berries clean, but with ordinary mulching material this will not be feasible, and in any case it is apt to interfere more or less with irrigation. Recently much discussion has taken place in regard to the length of time a strawberry bed should be maintained. Many contend it is more profitable to allow a strawberry bed to fruit only one year, renewing it every second year. With small beds such as will ordinarily be planted in this state, where well cared for and kept clean, we think that they may be maintained three or four years.

RASPBERRIES, BLACKBERRIES AND DEWBERRIES.—In planting these fruits plenty of room should be given, so that they may be easily covered with earth for winter protection. A letter from J. S. Meyer of Lander says:

"In planting our small fruits, we laid out rows, five feet apart for raspberries, blackberries, and dewberries, and planted them four feet apart in the rows. I find we got our berries all too close. If I were to set out anything like one-fourth acre or more to these fruits, I would have the rows seven feet apart and plant some vegetables between them the first year or two. In order to cover the canes easily with earth, it is better to have the rows wide."

The soil should be prepared in the same way as for other fruits, and cultivated often, at least after each irrigation. To insure their maturing and to increase their fruitfulness, the tips of the new canes should be pinched back after they reach a sufficient height in August, at which time, also, the irrigation should cease. After the old canes are through fruiting, cut them all out, and remove enough of the new canes to thin them properly, leaving only the stronger ones for next season's fruiting. Irrigate in the fall when the growth has stopped. After the soil has dried out sufficiently, before the ground freezes, lay the canes down

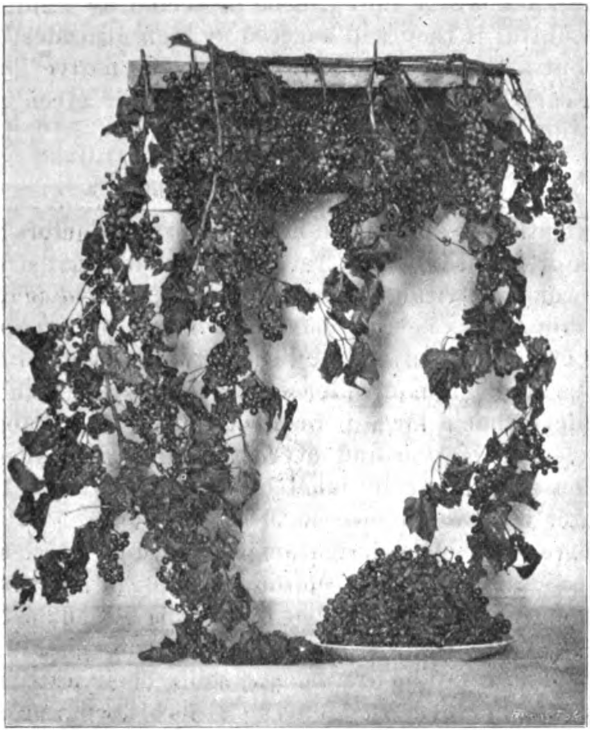
lengthwise in the row and cover deeply enough with earth to prevent their drying out through the winter. This can be done on a large scale with little trouble by using a sled, turned up a little in front and smooth underneath, so as not to injure the canes. This is drawn by two horses, one on each side of the row. A few shovelfuls of soil thrown upon the ends of the canes as the sled is drawn over them will hold them down. The covering can be finished by plowing along the sides of the row, throwing the soil over the horizontal canes. They should be uncovered in the spring before the buds throw out new shoots, but not so early that the flowers will come out in time to be caught by the late frosts.

GOOSEBERRIES AND CURRANTS.—These may be placed in rows four or five feet apart and four feet apart in the rows. Give the same preparation of the ground as for other fruits and give clean cultivation. They need pruning, to leave the stems somewhat open and at equal distances apart. As they become old and thicken up, cut out the old crooked and weak fruiting stems, leaving enough two-year-old stems for next year's crop. On account of their hardy character, it is not necessary to give them any winter protection other than a good mulch on the soil to retain moisture.

GRAPES.—We do not attempt to give any but the simplest directions for cultivating grapes in this state. They must be given thorough cultivation. Some writers claim that soil of only moderate richness is better than one which is very rich. The grapes upon the Lander experiment farm are planted in rows five feet apart, four feet apart in the row. We recommend giving them more room than this. Directions for pruning and different methods of training are given in horticultural works and need not be repeated here. The long vines should often be pinched back during the summer to help ripen the wood, and young shoots that are

out of place should be rubbed off as soon as they appear. After the leaves are dropped in the fall, the bearing shoots should be cut back, leaving two or three strong buds.

As it is necessary to lay the vines on the ground and cover with earth for the winter,in the same way as with rasp-



NATIVE GRAPES.
Collected in North Platte Canon by A. Nelson.

berries and blackberries, it is necessary to build the trellis and train the vines to it in such a way as to interfere least with this operation. Where the grapes are to be extensively grown, a low trellis of wire stretched between posts a considerable distance apart and supported between the posts

by stakes which are easily removed, is best. The vines can be easily taken down in the fall, the wire removed and the vines covered with a plow. Finish with a shovel, to insure their all being well covered. Grapes succeed best on soil with good natural drainage, along streams or near bodies of water, and where they can be protected by windbreaks. It is doubtful if they will succeed at high altitudes in this state, but at lower altitudes wherever the native grape is found, early and hardy varieties succeed if given proper cultivation and care.

IRRIGATION OF FRUITS.

Irrigation is one of the most important factors in the success or failure of fruit raising. An unirrigated region cannot compete with an irrigated one in the yield or quality of the crop. This is true of fruits to a greater extent than of any other class of plants. Directly proportional to the judicious application of water will be the success of the crop. We believe that a large percent of failures is attributable to careless irrigation and over-irrigation. The effects of water on soil and fruits must be carefully studied by the cultivator who would succeed.

Furrow or seepage irrigation is the system which should be followed. With the exception, perhaps, of strawberries, it may be generally stated that flooding is not advisable for any of the fruits we raise. Irrigating furrows should never have so great a fall as to wash the soil. Their proximity to the plants should depend on the absorbing power of the soil, the character of the subsoil, and somewhat upon the age of the plant. Water should never be allowed to touch the stems or trunks of shrubs or trees. Each irrigation should be thorough, and as the water is generally cold, should be finished as quickly as possible. If the water stands for any length of time around fruits, so that the ground remains saturated, great injury and retarding of

growth will result. Fruits should not be made to drink more water than they actually need. The amount required depends on the character and slope of the soil and subsoil, the condition of the weather, the kind of fruit, whether in bearing or not, and the season. Each irrigation should be followed by a thorough cultivation as soon as the soil is dry enough to be properly worked. During the early and middle part of the growing season, irrigation should occur often enough to keep the ground in a moist condition, but not wet. This is more essential during the bearing season for small fruits. During the latter part of the season, as a general rule, after the middle of August, irrigation should be stopped, so that the plants will cease growing rapidly, and have an opportunity to ripen their wood and develop buds. Late in the fall, before the ground has frozen, and when growth has ceased, the land should be thoroughly irrigated. The later this irrigation can be done the better, as the object is to store moisture in the soil sufficient for winter.

As we have before indicated, in the state papers, where orchards are planted on bottom lands that have a continual supply of moisture, fall irrigation may be unnecessary. But on upland it is the surest way to prevent trees from winter-killing, and when possible, irrigations through the winter will be found advantageous. Directly after the last fall irrigation, or after the first snow-fall, a heavy mulch will tend to prevent evaporation and sudden changes of temperature and hold the frost in the ground later in the spring, thus retarding a too early flow of sap. This is of great importance with us, as our open winters and warm spring days are apt to bring out the blooms in time to be destroyed by late frosts.

Strawberries may be flooded, if the rows are so well matted as entirely to shade the ground, but during the fruiting season the berries are apt to be soiled, occasioning con-

siderable loss. When in fruit they require considerable water. We have found it a good plan to pick the berries every other day, and irrigate every fourth day, or irrigate the day they are picked.

SUB-IRRIGATION.—As the word implies, this is furnishing water from below the surface. It is accomplished by laying pipes or tiling in the ground, with openings such distances apart as will allow the ground to be kept moist. The distance between the pipes and that between the openings in them, when they are used for small fruits, should depend on the character of the soil and the subsoil. In orchards pipes are usually placed along each row with an opening near each tree or between two trees. We have experimented with sub-irrigation for shade trees and believe it to be a great improvement over open ditches when once established. The great objection to this method is the first cost, which is too great, unless the land is very valuable and valuable crops are to be grown. Where porous tiling is used, unless it has to be shipped from a great distance, a system of sub-irrigation, where the soil is such that pipes can be placed twenty feet apart, will cot $300.00 an acre. Its advantages are entirely doing away with open ditches; effecting an economy in water, unless the subsoil is too porous; reducing the expense of applying water, as it requires no labor except turning the water on and off; applying the water from below in the natural way, thus preventing the cooling effects of evaporation as well as the baking of the surface soil. Each grower must decide for himself whether or not it possesses advantages for his farm sufficient to warrant the outlay.

RED CHERRY CURRANT. Raised by J. King, Laramie, 1897.

LARAMIE.

ALTITUDE, 7,200 FEET.

Very few have had sufficient faith in the possibility of growing even the hardiest kinds of fruit upon the Laramie Plains to give the matter more than a passing thought. A few, however, have boldly hazarded their time, labor, and money,and their success has been worth many times the trouble and cost. The fact has been demonstrated that even under our conditions of altitude and climate, hardy varieties will succeed, if they are properly cared for and given shelter from the drying winds of the winter season. Our work with fruit upon the experiment farm has given us little to report. As a rule the results have been negative rather than otherwise. We have planted a great number of kinds and varieties in the hope that some might be found which would succeed without the protection of wind-breaks and winter irrigation.

The Station farm is situated upon the open plain, without any object that will break the force of the winds. From six to eight months of the year the farm is without water with which to irrigate, and the soil becomes so dried out that few plants can survive in it. However, under these conditions, our hardy apple trees, such as Siberian Crabs and Ben Davis, lived through three seasons, and some varieties of small fruits have borne. The following is a brief report upon those kinds and varieties fruited, arranged in order of their hardiness:

CURRANTS.

Of the varieties that have been grown, the Red Cherry, White Grape, and White Dutch have been fruiting each year. One black variety, namely, Lee's Prolific, has suc-

ceeded fairly well, and the Crandall produced vigorous vines, but only a small amount of fruit.

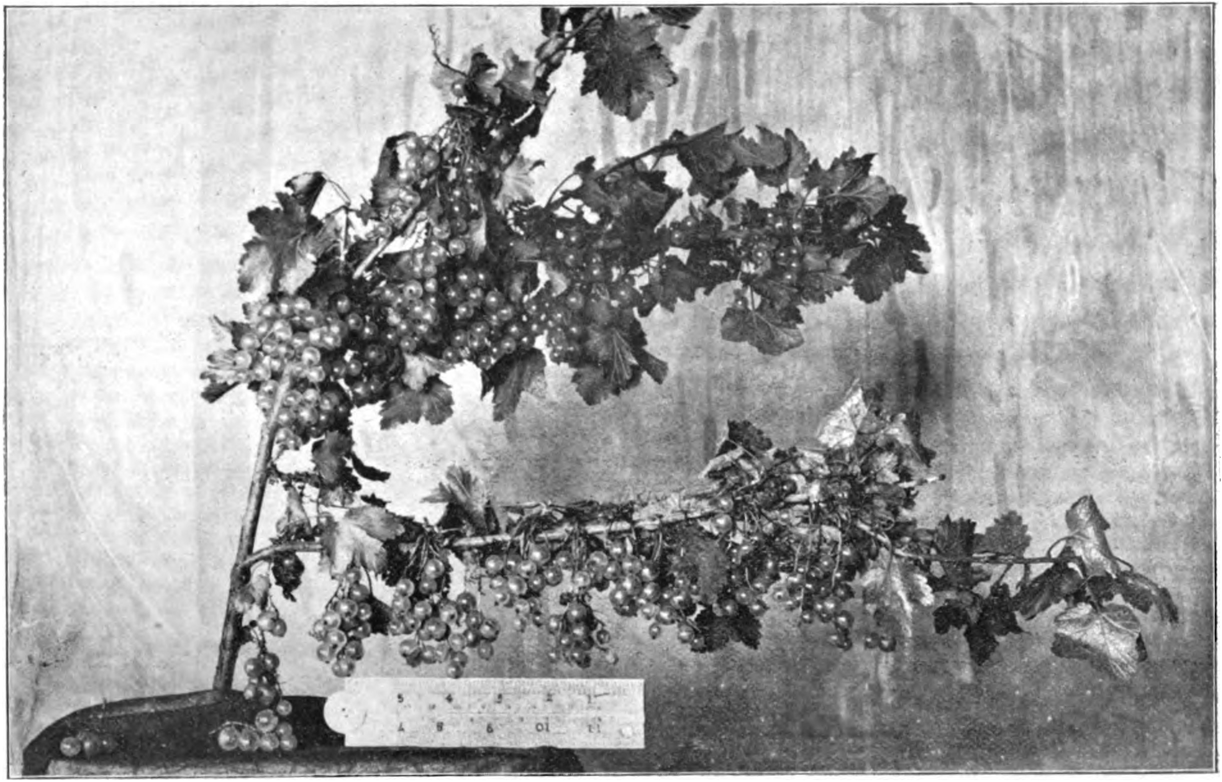
DEWBERRIES.

Of a large number of varieties of blackberries, raspberries, and dewberries, the Lucretia Dewberry has proved the most hardy. All the other plants winter-killed. The few vines of dewberries were given almost no attention after the first season. With a comparatively small amount of irrigation, they have lived through the winter and ripened some fruit. We have no doubt that, where they are given some protection, they will prove very successful.

STRAWBERRIES.

A large number of varieties of strawberries was planted in the spring of 1892. The plants were obtained from different nurseries in the United States, some being pot-grown plants which had been raised in the greenhouses of the east. Not only here, but in other parts of the state as well, the pot-grown plants seemed too tender, and were the first to succumb. The plants obtained from the Colorado nurseries seemed more hardy and lived longer than the others.

An experiment to determine the best method of winter protection was carried out during the winter of 1892 and 1893. One-third of the plants of each variety was left uncovered, one-third was covered with straw and litter, and one-third was covered with earth. The water in the soil dried out and nearly all of the plants died. Only a few of those covered with soil came out alive in the spring and these died later. In 1896 a new experiment with strawberries was begun. Four varieties were planted about August 20, and were irrigated late in the fall and covered with coarse litter. About one-half of the plants died during the winter,



WHITE GRAPE CURRANT. Raised by J. King, Laramie, 1897.

but the others have grown well this summer, and the Vick and Warfield have ripened fruit. We believe the strawberry industry will meet with success where the plants can be irrigated sufficiently in the winter and have some protection. It should be profitable to raise them for market here, as they will ripen late in the season, after all other berries are out of market. Its season will be from two to three weeks later than that of other places where strawberries are raised for shipment. In town and on ranches along streams, some of our people are successfully growing strawberries for their own use.

GOOSEBERRIES.

While no gooseberries have fruited, with the exception of a very few berries on one variety during one season, the vines lived through the winter without other protection than a light mulch. The varieties which seemed most hardy were Houghton, Industry, Charles Downing, and Golden Prolific.

Fruit Notes on the Laramie Plains.

A few ranchmen on the Laramie Plains have attempted to raise fruits with varying success. In the winter of 1891-92, Mr. E. S. R. Boughton of the northern part of Albany county, stated that all the fruit trees planted in that section had died. In many sheltered localities there are fruit trees now growing and some of them are bearing creditable crops. In sheltered yards in Laramie a number of people have succeeded in growing hardy apples. Hon. Edward Ivinson has a number of fine trees of standard sorts in his yard and some of them have matured fruit. Judge M. C. Brown has two fine Siberian Crab trees which have borne heavy crops

for a number of years. We present a cut of one of these trees. Hon. Otto Gramm has some fine trees, and Mr. Ora Haley has succeeded in ripening some apples in his yard.

Outside of town, on many of the ranches, are sheltered situations where hardy tree fruits will succeeed. We know of only one ranchman, however, who has trees now bearing fruit.

MR. LUND'S SUCCESS.

Mr. Jacob Lund, whose ranch is situated 25 miles from Laramie on the Big Laramie river and near the mountains, has given fruit raising attention in a small way. Five years ago he purchased some two year old apple trees from a Colorado nursery and planted them on bottom land. Timothy was planted among the young trees and the second year the grass grew so high as to shade and greatly injure the trees. He states also that the trees were injured by being kept too wet, for in addition to the moisture on the bottom land they were irrigated freely, the ground having been kept soaked with water. The trees have been given no winter protection, but they have grown well and are now bearing nicely. When five years old one tree bore a single apple; last year this tree had six small apples on it, and this year the same tree bore forty fine, large apples, which ripened. On October 20 Mr. Lund brought four of these apples to the University. As he could not state the variety, one of them was sent to Prof. L. H. Bailey of Cornell University, who, with other experts, examined it and reported it to be a Wealthy. We show cuts of these apples, both natural size, and smaller taken with a scale to show the size. Mr. Lund has also ripened a few cherries (probably Morello) and has some thrifty plum trees. He has met with considerable success in raising strawberries and currants. He stated that his family could not afford to purchase fresh fruit from the markets and never knew what the luxury meant until his

WHITE GRAPE CURRANTS, Natura Size.
Raised by J. King, Laramie, 1897.

SIBERIAN CRAB. Laramie, 1891.
Raised by M. C. Brown.

strawberries came into bearing, after which they had all the fruit they could use. Mr. Lund practices fall irrigation. Water is kept away from the tree and other fruits during the fall while they are ripening their wood. After everything begins to freeze and the leaves have fallen from the trees, they are thoroughly irrigated to keep them from drying out during the winter.

SMALL FRUITS.

A number of our ranchmen have raised small fruits. Mr. James King, whose ranch is 18 miles west of Laramie, has raised remarkable crops of the White Grape and Red Cherry currants. Illustrations of these, made from photographs, are shown. The fruit is used principally for making wine and jelly.

Mr. A. S. Foster, who has a ranch in the Centennial valley, has raised abundant crops of strawberries and raspberries. He has informed us that he has plantations of the wild varieties of raspberries and strawberries which have produced excellent crops.

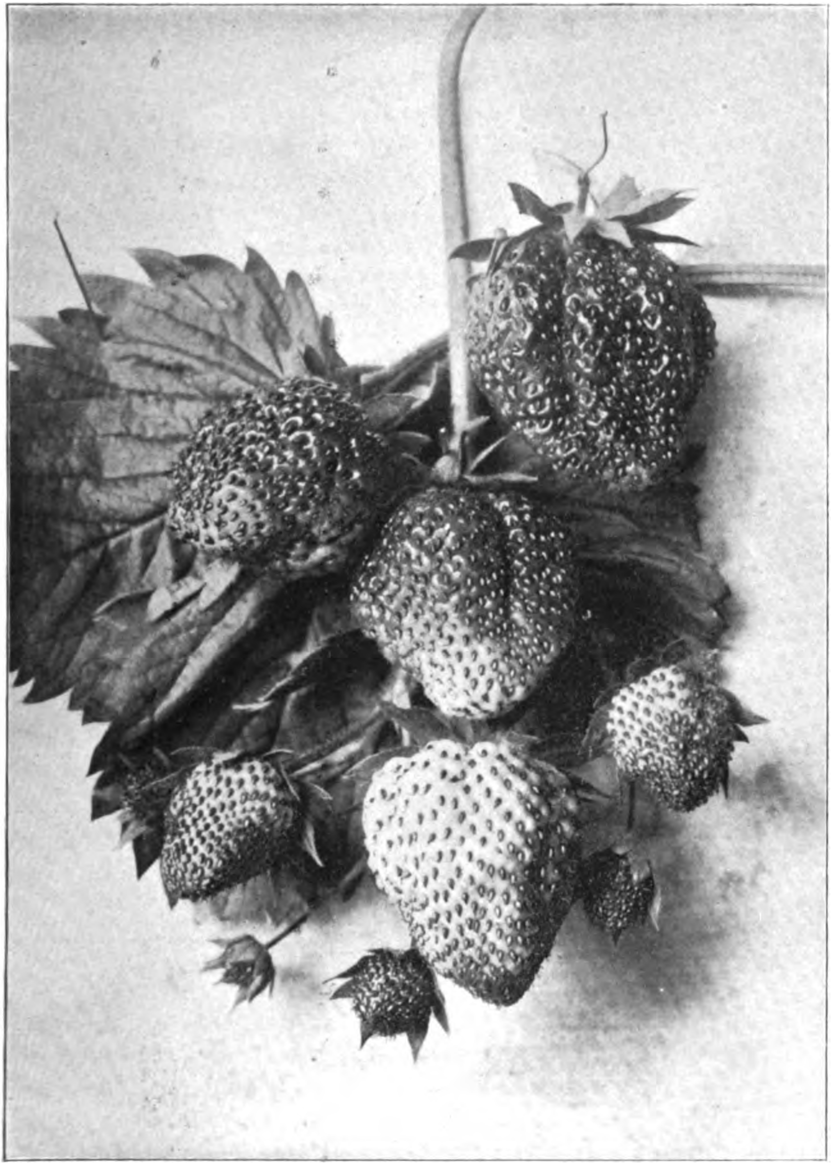
LANDER.

The town of Lander is situated in the fertile valley of the Big Popo Agie river, and is at an altitude of about 5,300 feet. It is surrounded by a farming country well adapted to the production of fruits. The nearness of the Wind River mountains to the arable land of the valleys gives it protection from the winds and cold. The streams from the mountains give abundant water supply. The water is very pure, containing almost no salts of any kind.* On account of the water being so cold and abundant, seepage or furrow irrigation is generally practiced for all crops.† The soil of the bottom lands along the streams is black alluvial deposit, while that of the bench lands‡ is red sandy loam which is of great depth, there being no apparent distinction between the surface and sub-soil. In both the Big and Little Popo Agie valleys farmers have been producing hardy fruits for a number of years, and in sufficient quantity to remove all doubt as to their adaptability to the soil and climate of that region.

Fruits Upon the Experiment Farm.

From the fruit experiments upon the Lander farm we have obtained some data of value, which, with the experience of farmers of that region who are growing fruit, enable us to state with considerable accuracy what may be done in fruit growing in that section. The farm of the sub-station, located six miles west of Lander at an altitude of about 5,500 feet, was established in 1891. In the spring of 1892 as ex-

*See Bulletin No. 24, Water Analyses, page 119.
†See Bulletin No. 8, page 19.
‡See Bulletin No. 6, page 17, and Bulletin No. 14, page 108.



CHARLES DOWNING STRAWBERRY, Natural Size. Lander, 1897.

tensive plantings of fruits were made as available funds would allow, and these have been increased to some extent by plantings made since. The fruit plats are on the first bench above the river. Most of them have a gentle slope toward the north.

Between three and four acres of fruits have been growing since 1892. The experiments received a severe check in the fall of 1895 and during the following winter. On this account complete reports of all fruits have not been furnished the past two seasons.

ORCHARD FRUITS.

With the exception of a few trees, the young orchard on the experiment farm has not come into bearing. However, we think a report of all the varieties planted, with a brief history of their growth up to the time of the destructive freeze of September, 1895, will indicate something of the hardiness and adaptability of the varieties which have been grown. Our report practically ends with the fall of 1895.

On September 20th of that year, when the trees were still in full leaf, the temperature suddenly dropped twenty degrees below freezing point, and as Mr. Meyer points out in his letter, young trees which had been set out only two or three years were nearly all destroyed. This storm was one of those rare occurrences which occasionally happen in all parts of the country, and which are especially discouraging in a new region where plantings of fruit are just beginning to be made. So destructive was it, that many native cottonwoods and other trees are said to have perished. However, we were fortunate in having orchards in the different sections of the state that had been planted long enough to escape with comparatively little damage. If this were not the case, we should still have no proof that orchard fruits will succeed. We feel sure that they will succeed regardless of any unusual freak of the weather. On account of lack of

funds, the trees killed have not been replaced on the experiment farm.

The first two winters after setting out the trees they were protected by wrapping the trunks with paper and burlap, put on in December. During the second winter, winter rye was grown on the land between the trees and plowed under in the spring. The superintendent states that this so loosened the ground that the soil was put in better condition of tilth and that it took up the water much better when irrigated.

Because we attach some importance to the locality from which trees are obtained, in the following report we have indicated the nurseries from which they were purchased. A comparison of the success of eastern and western grown trees, the first year after planting, may be of interest. Sixteen varieties with a total number of one hundred forty-six trees were obtained from Green's nursery of Rochester, N. Y., in the fall. They were received in good condition, pitted for the winter, and set out in the orchard in April of 1892. Of the one hundred forty-six trees, fifty-six, that is, about thirty-eight per cent, died the first year. In the spring of 1892 nine varieties, or a total of fifty-two trees, were obtained from Shields' nursery of Loveland, Colorado. These trees were taken up in the spring, boxed in the usual way, and shipped to Lander by freight. On account of the long distance from the railroad, these trees were over a month on the road, and the superintendent reported them in very bad condition when received. Some of them were so far advanced that when the box was opened they were found in blossom, and it was June before they were set out in the orchard. Of fifty-two trees planted, nine, or about seventeen per cent, died the first year.

In order to determine whether the different varieties obtained from each place would account for the greater loss of eastern trees, we have compared the three hardy varieties,

BRIAR SWEET CRAB IN BEARING.

Orchard of J. S. Meyer, Lander, 1895.

Ben Davis, Oldenburg, and Wealthy, which were purchased from both nurseries. Of forty trees of these varieties obtained from New York, thirteen trees, or thirty-two and one half per cent, died the first year. Of eighteen trees of the same varieties from Colorado, three trees, or sixteen and two-thirds per cent, died the first year. To be strictly accurate, the success of trees taken from the nursery and shipped in the fall is not comparable with the success of those taken up and shipped in the spring.

In this case, however, if there is an error from this cause, it does not change the result, but would rather strengthen it. We have reason to believe the difference shown would be much greater than it is, if both had been given the same treatment. The trees obtained in the fall and planted with the opening of spring, had so much in their favor that it was natural to expect a smaller percent of loss.

Under the circumstances, then, the comparison is legitimate, and the conclusions to be drawn from it may be depended upon. They strengthen the belief that western grown trees will succeed better under our conditions than those which are in no wise acclimated.

Apples.

The following varieties were obtained from Green's nursery of Rochester, N. Y., in the fall of 1891. They were heeled in, by being entirely covered with earth. In April, 1892, the trees were set out in the orchard. All the trees were two years old when planted. The roots of some of the trees were injured by field mice, which made their nest in the pit with the trees. The varieties injured in this way are indicated by an asterisk after the name.

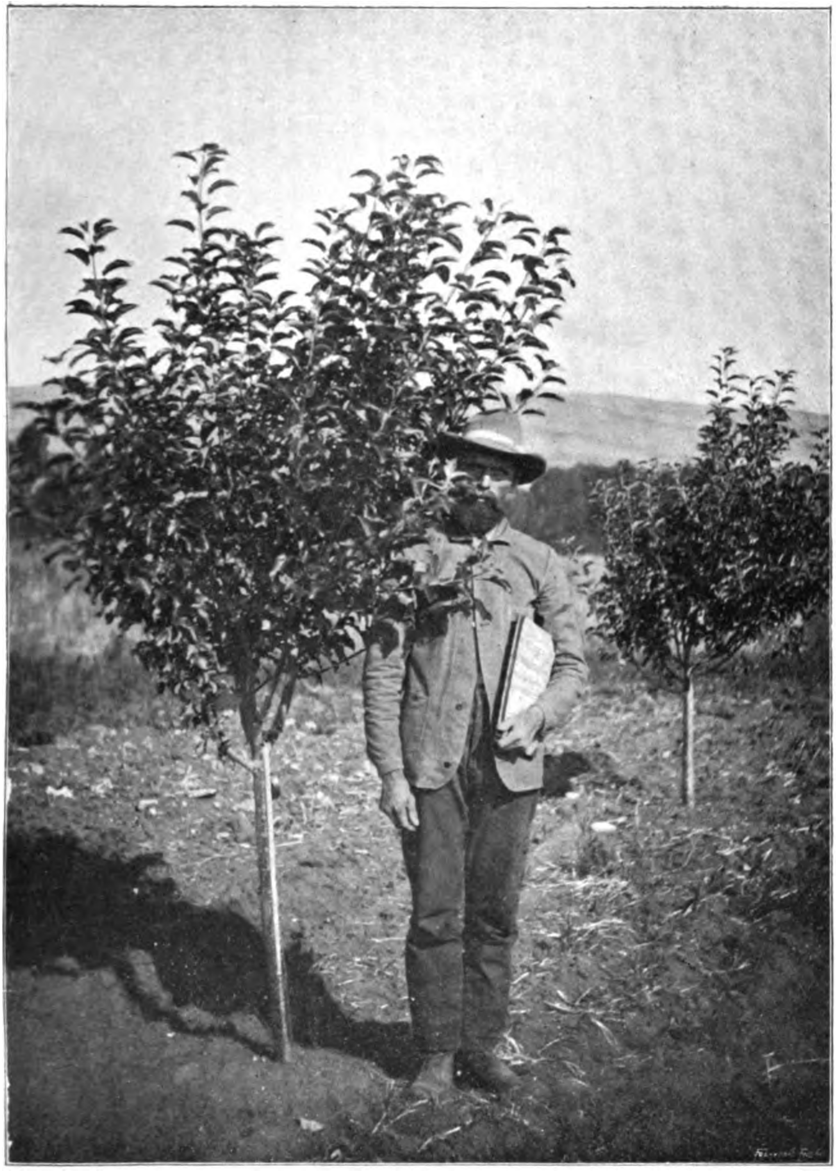
No. planted.	Variety.	Highest trees in fall of 1895.	Remarks.
9	McIntosh Red*	6 ft., 4 in.	Early winter apple.
12	Baldwin*	4 ft., 6 in.	Winter apple, not hardy.
16	Wealthy	8 ft., 7 in.	Hardy, fall apple.
17	Fameuse	7 ft., 9 in	Late fall, apparently hardy.
12	Oldenburg	7 ft., 1 in.	Early fall, apparently hardy.
12	Ben Davis	8 ft., 0 in.	Winter apple. One tree matured an apple in 1895.
9	Yellow Transparent	7 ft., 9 in.	Winter apple.
9	Red Bietigheimer	5 ft., 11 in.	Fall apple.
9	Tetofsky	6 ft., 5 in.	Summer, hardy.
9	Golden Russet	5 ft., 10 in.	Winter, apparently not hardy.
10	Pewaukee	7 ft., 1 in	Winter apple.
9	Sweet Bough	6 ft., 8 in.	Summer apple.
3	Grimes' Golden Pippin*		Late fall; all died.
4	Tallman Sweet*		Winter; all died.
3	Gravenstein*		Fall; all died.
3	Wolf River		Winter.

The following varieties were obtained from O. D. Shields' nursery of Loveland, Colorado, and shipped to Lander in the fall of 1892. They were so long en route that all were much damaged, and were received so late that it was June before they were planted in the orchard.

No. planted.	Variety.	Height of tallest, fall of 1895.	Remarks.
6	Gano	7 ft., 6 in.	Winter.
4	Martha Crab	8 ft., 2 in.	Fall.
6	Whitney Crab	7 ft., 6 in.	
6	Hyslop Crab	7 ft., 8 in.	Fall.
6	Oldenburg	7 ft., 5 in.	Early fall.
6	Ben Davis	8 ft., 0 in.	Winter.
6	Yellow Transparent	7 ft., 9 in.	Winter.
6	Red Astrachan		Summer.
6	Wealthy	7 ft, 7 in.	Fall.

The following varieties from O. D. Shields were set out in the spring of 1894:

No. planted.	Variety.	Height of tallest, fall of 1895.	Remarks.
11	Haas	6 ft., 5 in.	Fall.
5	Pewaukee	7 ft., 1 in.	Winter.
6	Tallman Sweet	5 ft., 9 in.	Winter.
5	Oldenburg	7 ft, 5 in.	Early fall.
4	Hyslop Crab	7 ft, 8 in.	Fall.
6	Utter's Red		Trees one year old, early winter.
8	Golden Pippin		Trees one year old, late fall.
10	Jonathan	5 ft., 1 in.	Winter.
4	Ben Davis	8 ft.	Winter.
5	Walbridge	6 ft.	Late winter.



BEN DAVIS APPLE TREES. Lander, 1895.

Apricots.

While no apricots have borne fruit, the trees have lived fairly well and made excellent growth. In May, 1892, there were planted two each of J. L. Budd, Gibb, and Alexander, and in June three Russian apricots. Those planted in June were so long on the road that they were probably dead when received. Those planted in May lived through the first winter, the Gibb making the largest season's growth of any tree set out. One of the Alexander apricots was growing well in 1895, having made a shapely tree six feet high.

Cherries.

Five trees were planted in May, 1892, having been obtained from Spear, of Greeley, Colorado. These were Sport Amorilla, so called, and two unnamed. In June six English Morello and six Early Richmond from Shields were planted. As it was so late when they were received, seven of the twelve trees died the first year. The trees which lived of both English Morello and Early Richmond ripened a few cherries in 1893. In the spring of 1894 three trees of the English Morello and four of the Early Richmond were again planted. In 1895 the tallest trees of English Morello were five feet high, and the tallest of Early Richmond were six feet, eleven inches. These two varieties are very promising at Lander.

Pears.

From Spear's nursery were obtained three Gakovska and three Bessemianka, and from Shields' six each of Keiffer, Flemish Beauty, Bartlett, Clapp's Favorite. Those which seem to be the most hardy, in their order, with the height reached by each, are: Gakovska, eight feet, eight inches; Bessemianka, seven feet, two inches; Flemish Beauty, seven feet, nine inches; Keiffer, eight feet, six inches; Clapp's Favorite, seven feet. Bartlett does not seem to be

hardy. Three Clapp's Favorite and one Flemish Beauty were also set out in the spring of 1894.

Plums.

The following varieties obtained from Shields' were set out in June, 1892. The trees were three years old.

6 Abundance—Highest trees 4 ft., 8 in.
5 De Soto—Bloomed in 1893; ripened some fruit in 1895; tallest trees, 7 ft., 10 in.; hardy.
6 Weaver—Tallest trees, 6 ft., 3 in.
6 Hawkeye—Tallest trees, 7 ft.

The following varieties from Spear were set out in May, 1892. Most of them were dead, or nearly so, when received.

1 Botan—Same as Abundance.
2 Chabot.
3 Simmons (?) Probably Simon.
1 Simon.
4 Pottawattamie.

From O. D. Shields and set out in spring of 1894:

1 Hawkeye.
1 De Soto.

Of the varieties tried, the De Soto, Weaver, and Hawkeye have proven most hardy.

Quinces.

Two trees each of the Champion and Mammoth quince were planted, but they did not live the first year, and under the conditions, no conclusions can be drawn as to whether they will or will not succeed.

GRAPES.

At the time the vineyard was planted, little confidence was placed in any of the varieties succeeding. Letters from Fremont county stated that all small fruits, with the ex-

VINEYARD. Lander, 1895.

ception of grapes, would succeed. Some of the varieties are bearing excellent crops and have proved early enough to mature the fruit before the time of frost. The vineyard is located on the first bench above the river bottom. Our illustration gives a very good idea of its appearance in the summer of 1895, which was the second season any fruit was borne.

The vines have been protected through the winter by being covered with earth. The vines are laid down about the 10th of November and uncovered the last of April. They are fastened up to stakes during the summer and given clean cultivation. The record of each variety up to the season of 1897 is given separately.

CONCORD.—Seventy-one vines one year old were obtained from Green's nursery, Rochester, N. Y., and set out in May, 1892. Twenty-five of them died the first year, but the others made good growth. Thirteen vines obtained from Lovett of New Jersey were set out at the same time and all lived. During the second winter fifteen more of the vines died. In the summer of 1894, eleven pounds of fruit matured, ripening from September 15th to 22nd, and were pronounced of excellent quality. In 1895, when the photograph from which the illustration was made for that year was taken, the vines had well-formed bunches of fruit. The grapes were just beginning to ripen September 7th, at the time of the frost. We have at hand no record of the grapes for 1896.

In 1897 the Concord bore heavily, as is shown in our illustration taken this fall. This picture also illustrates the increase in productiveness since 1895. We have no record of the amount produced by each vine or of the number of vines which have lived through each winter since 1894.

WYOMING RED.—Eighteen vines from Rochester, N. Y., were planted in May, 1892. Four of these died the first year and two died the second year after planting. The oth-

ers made good growth and bore the first fruit in 1894, when four pounds of grapes ripened. In 1895 there were well formed bunches of grapes on the vines, but they did not ripen before the frost killed them on September 7th. We have no record for 1896, but this season they bore heavily, as can be seen by referring to our illustration made from a photograph this year. The Wyoming Red ripens about the same time as the Concord, and these two varieties have been more successful than the others tried. From the two varieties, sixty-five pounds of fruit was harvested this season.

BRIGHTON.—Twelve vines from Lovett were set out in May, 1892. All lived the first season. Seven vines died the second winter, and no fruit was formed in 1894. In 1895, when our photograph was made, a few bunches were formed, but they did not mature. We have no later report upon this variety.

MOORE'S DIAMOND.—Ten vines from Lovett were set out in May, 1892. These lived the first season, but six died during the second winter. A few scattering grapes ripened on September 22, 1894. In 1895 there were some fair bunches of grapes (see illustration) but they did not mature.

DELAWARE.—Twelve vines from Lovett were planted in May, 1892. None died the first season, but the second winter nearly all died, as they were not covered deeply enough with soil to keep them from drying out. In 1895 there were well formed bunches of grapes, as shown by illustration. These did not fully mature, but were ripening at the time of the frost, September 7th. The variety has not been reported upon since 1895.

MARTHA.—Thirteen vines from Lovett were planted in May, 1892. These lived the first season, but most of them died during the second winter, as they were not covered deeply enough. In 1895 the vines left set a few bunches of

CONCORD GRAPE. **Lander, 1895.**

CONCORD GRAPES. Lander, 1897. *Photo by Scott.*

WYOMING RED GRAPES. Lander, 1897

Photo by Scot.

DELAWARE GRAPE. Lander, 1895.

BRIGHTON GRAPE. Lander, 1895.

MARTHA GRAPE. Lander, 1895.

MOORE'S DIAMOND GRAPE. Lander, 1895.

JAPANESE WINEBERRY. Lander, 1895.
(*Illustration was first published in "American Gardening."*)

grapes (see illustration) ,but these failed to ripen before frost. This variety has not been reported since 1895.

GREEN MOUNTAIN.—Seven vines from Lovett were planted in May, 1892. These lived through the first year, but all died the second winter because they were not covered deeply enough.

SMALL FRUITS.

Blackberries and Dewberries.

The first three varieties of blackberries given in Table I were obtained from Peter Henderson, New York; numbers four to eight, inclusive, from Lovett, New Jersey, and number nine from Shields, Colorado. The Dewberries were obtained from Shields, Colorado.

In Table III, those varieties of blackberries with an asterisk following their names were frosted on September 7th while much of the fruit was still green. The last three varieties, of which the yields are not given, produced some fruit, but the frost prevented the greater portion of it from maturing.

Table IV gives the results in 1895 with the dewberries. Both varieties produced large, fine fruit, but the Mammoth is the most prolific. Of the varieties of blackberries tried, the Early King and Stone's Hardy are best. Our illustrations show the character of the fruit. None of the varieties produced large yields until the third season after planting.

TABLE I.—*Blackberries, Lander, 1894.*

No.	Variety.	Date set out.	No. set out.	No. died first year.	No. died second year.	Date first ripe in 1894.	Remarks.
1	Wilson, Jr . . .	May, 1892	24	. . . .	9	Aug 5	Berries large, canes stiff.
2	Erie.	" "	13	. . . .	4	Aug. 13	
3	Lawton	" "	16	12	1	No fruit	Not hardy.
4	Lovett's Best .	" "	7	. . . .	1	Aug. 8	Good quality.
5	Child's Tree . .	" "	6	. . . .	4	"	A few berries.
6	Early King . .	" "	26	. . .	6	July 23	Earliest.
7	Early Harvest .	" "	26	. . . .	16	No fruit	
8	Stone's Hardy.	" "	12	2	4	Aug. 8	Very prolific.
9	Kittatinny. . .	June, "	7	. . . .	4	"	

TABLE II.—*Dewberries, Lander, 1894.*

Variety.	Date set out.	No. set out.	No. died first year.	No. died second year.	Date first ripe in 1894.	Remarks.
Lucretia	May, 1892	13	11	....	July 12.	A few berries.
Mammoth.	" "	12	9	....	"	Very large.

TABLE III.—*Blackberries, Lander, 1895.*

Variety.	In bloom.	First ripe.	Last picked.	Yield per acre in quarts.
Early King	June 12	July 24	Sept. 25	1278
Wilson Jr.*	" 22	Aug. 14	" 7	524
Stone's Hardy*	July 4	" 23	" "	1118
Lawton*	June 25	" 5	" "	.....
Erie*	" "	" 20	" "	.....
Lovett's Best*	" "	" "	" "	.....

TABLE IV.—*Dewberries, Lander, 1895.*

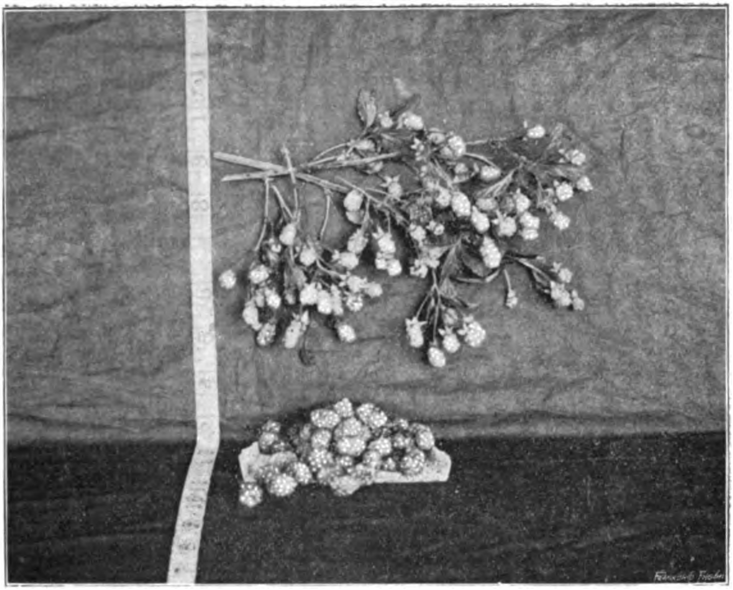
Variety.	In bloom.	First ripe.	Last picked.	Yield per acre in quarts.
Mammoth	June 22	Aug. 3	Sept. 5	2023
Lucretia	" "	" 5	" "	1231

Currants.

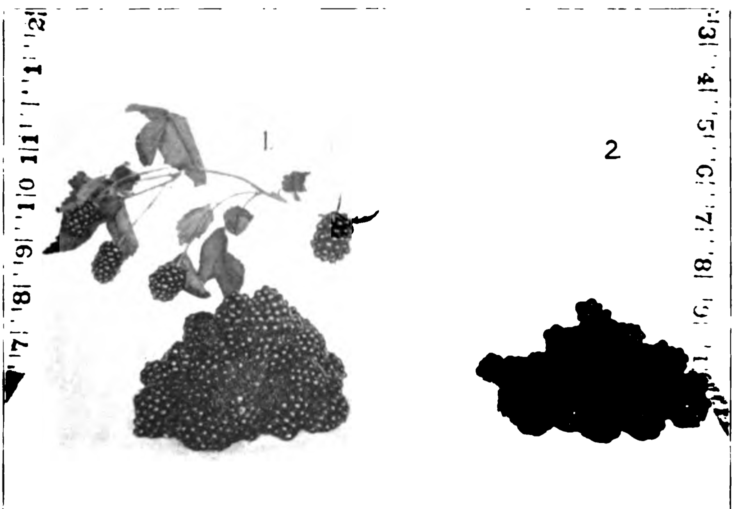
The following varieties obtained from Lovett were set out in May, 1892. None died the second year.

	No. planted.	Died first year.	Age of plants.
White Grape	24	0	2 years
Red Cherry	31	7	1 year
Lee's Prolific	24	1	2 years
Holland	12	0	1 year
Black Naples	12	0	1 year
Crandall	27	2	2 years

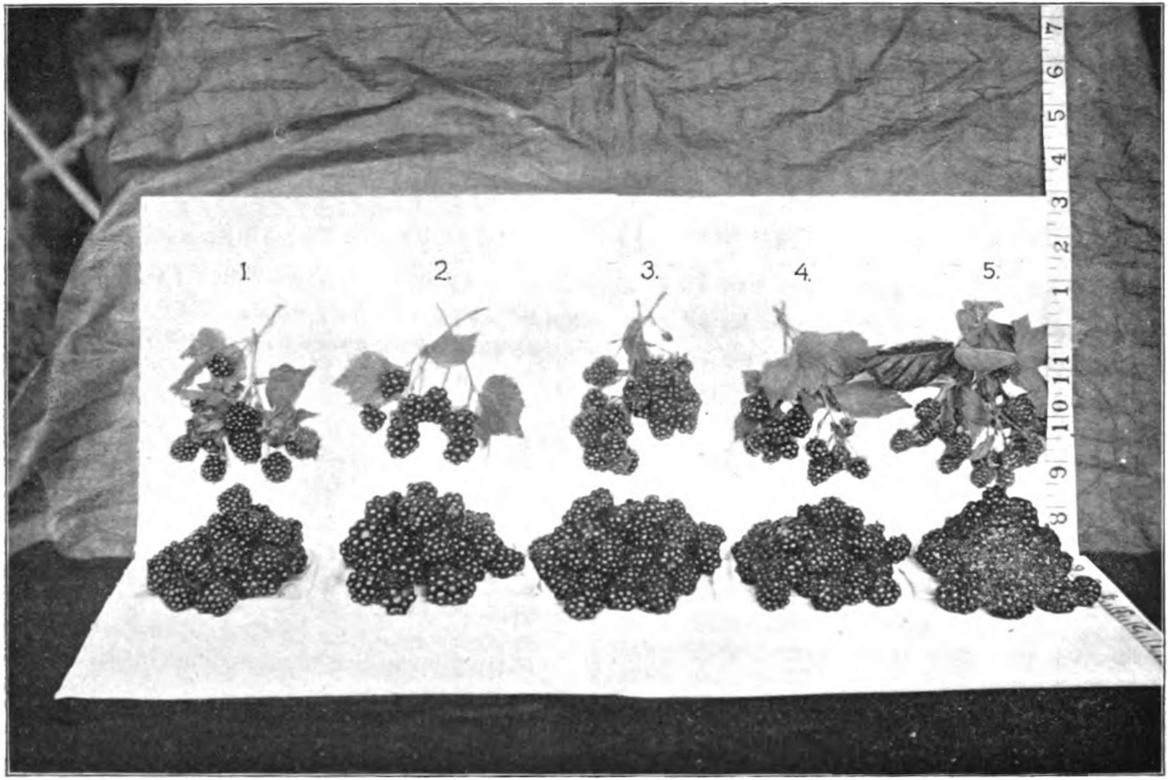
In 1894 the White Grape, Red Cherry, and Lee's Prolific bore fruit. The White Grape was very productive, ripening June 30. The Red Cherry was ripe July 12. The "crickets," (a species of grasshopper belonging to the genus Anabrus) which were so destructive in 1894 in the Lander valley, destroyed the larger part of the fruit of the White Grape cur-



CRYSTAL WHITE BLACKBERRIES. Lander, 1895.



DEWBERRIES. 1, Lucretia. 2, Mammoth. Lander, 1895.



BLACKBERRIES. 1, Erie. 2, Wilson Jr. 3, Stone's Hardy. 4, Lovett's Best. 5, Child's Tree. Lander, 1895.

rants. The strong flavor of Lee's Prolific prevented the crickets from bothering them.

Following is a report upon each variety fruiting in 1895:

HOLLAND.—This is similar to the old White Dutch. The fruit is white and transparent. It was all ripe and picked July 17th. The crop was not heavy, the yield being at the rate of 2722 quarts per acre.

WHITE GRAPE.—Fruit was ripe and harvested July 18th. Berries are white, transparent. This variety gave the heaviest yield, producing at the rate of 11,570 quarts per acre.

RED CHERRY.—Berries are large and red. They were ripe and harvested on July 19th. This variety yielded at the rate of 7260 quarts per acre.

LEE'S PROLIFIC.—The berries are large and black, with a strong odor and flavor unpleasant to many. They were ripe and harvested July 25th. The yield was at the rate of 4310 quarts per acre.

BLACK NAPLES.—This variety is much like Lee's Prolific, the berries having much the same odor and flavor. They were harvested July 25th, and yielded at the rate of 1533 quarts per acre.

Gooseberries.

DOWNING.—Twenty-four plants obtained from Lovett's nursery of New Jersey were planted in May, 1892. The plants were one year old when set out. Six of the number died the first year. In 1894 some fruit was produced, which was ripe by July 20. In 1895 the berries were harvested August 13. The yield was at the rate of 13,159 quarts per acre. The berries are light green when ripe, large, and of excellent quality. The bushes have proved to be hardy and prolific. The superintendent says "this is the gooseberry to grow for profit." The illustration of this variety shows

branches loaded with fruit, some of the berries measuring nearly three-fourths of an inch in diameter.

GOLDEN PROLIFIC.—Six one-year-old plants were obtained from Lovett and set out in 1892. One of them died the first year. On July 20, 1894, some fruit ripened. The berries were very large but the bushes made poor growth.

SMITH'S, INDUSTRY, AND HOUGHTON.—Twelve of each of these varieties were obtained from Spear of Colorado and were planted in May, 1892. Nearly all of them died the first two years and none of them succeeded. As the last two have been hardy in other parts of the state, we think they should be given further trial.

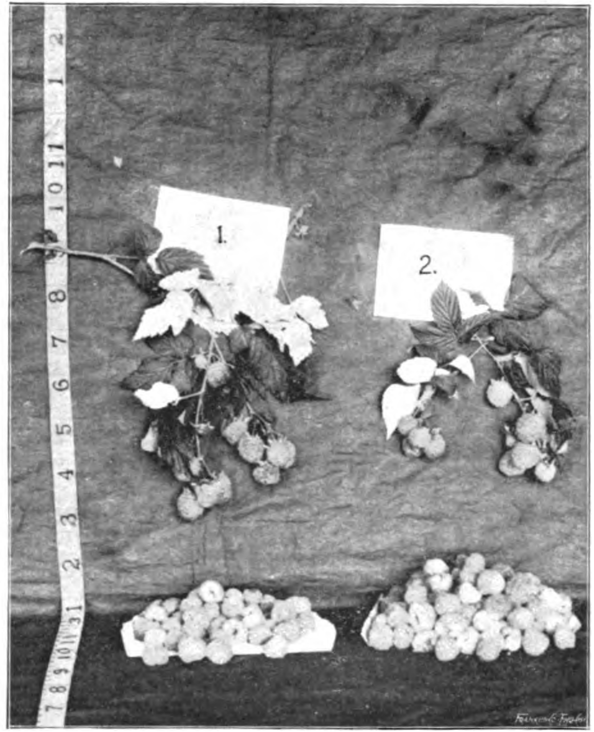
Raspberries.

No fruit was obtained until the season of 1894. Those which died during the previous winter, as indicated in the table, were not covered deeply enough with earth to save them. Miller's Daily and Mammoth Cluster did not grow after being set out. Of the red varieties, the Turner and Hansel are best. They are both prolific and of good quality. Early Prolific was the earliest and most prolific variety, but the berries are not of so good a quality, as they crumble when picked.

Among the blackcaps, the Lovett was earliest, and a very good cropper. Kansas and Progress were most prolific and Gregg one of the finest in quality.

The Golden Queen and Caroline, which are yellow varieties, seem much alike, as shown in the illustration. We distinguish no difference in time of blossoming, time of ripening, length of fruiting season, color, quality, or appearance of the canes. However, the Golden Queen has seemed more thrifty and has been more prolific than the Caroline. Some of the varieties which died from being insufficiently covered in winter will undoubtedly prove of

DOWNING GOOSEBERRY. Lander, 1895.



RASPBERRIES. 1, Caroline. 2, Golden Queen. Lander, 1895.

value. There is a good demand for raspberries in the Lander market. Those marketed in 1894 sold for 33 1-3 cents per quart.

Raspberries, 1894.

Variety.	No. planted.	Obtained from.	No. died.	Date ripe, 1894.	Remarks.
RED—					
Turner	25	Lovett	....	July 8	Prolific
Early Prolific	15	"	....	June 30	Early
Hansel	25	Henderson	....	July 12	One of best.
Brandywine	27	"	....	July 12	Good.
Everbearing	14	Shields	All	.....	
Cuthbert	23	"	All	.....	
YELLOW—					
Golden Queen	26	Lovett	....	Aug. 2	Large. Good.
Caroline	15	Henderson	....	.....	
Brinkle's Orange	10	"	All	.....	
BLACK—					
The Lovett	12	Lovett	....	July 8	Good.
Ada	24	"	8	July 27	Only a few.
Gregg	24	"	....	July 27	One of best.
Kansas	12	"	....	July 12	One of best.
Ohio	12	Spear	All	.....	
Mammoth Cluster	24	"	All	.....	
Progress	14	Henderson	All	.....	
Everbearing	12	Shields	All	.....	
Miller's Daily	.....	"	All	.....	
Souhegan	24	"	All	.....	
Congress	14	....	....	July 8	Productive.

Raspberries, 1895.

Variety.	In bloom.	First ripe.	Last picked.	Yield per acre in quarts.
RED—				
Brandywine	June 22	July 20	Aug. 21	1605
Marlboro	" 12	" 8	" 17	1746
Early Prolific	" "	" 6	" "	3289
Hansel	" "	" 8	" 21	2259
Turner	" 15	" 13	" 17	3160
BLACK—				
Ada	" 22	" 25	" 21	1815
Gregg	" "	" 24	" "	876
Progress	" 15	" 15	" "	2674
Kansas	" "	" 18	" 17	2425
Lovett	" "	" 20	" 7	1705
YELLOW—				
Golden Queen	" 12	" 7	Sept. 7*	3131
Caroline	" 15	" 10	" "*	1149

*Frosted Sept. 7th. There was still some green fruit on bushes at this time.

Japanese Wineberry.

Our experience with this berry does not indicate that it will be profitable to grow for market. The plants did not come into bearing until the third season after setting them

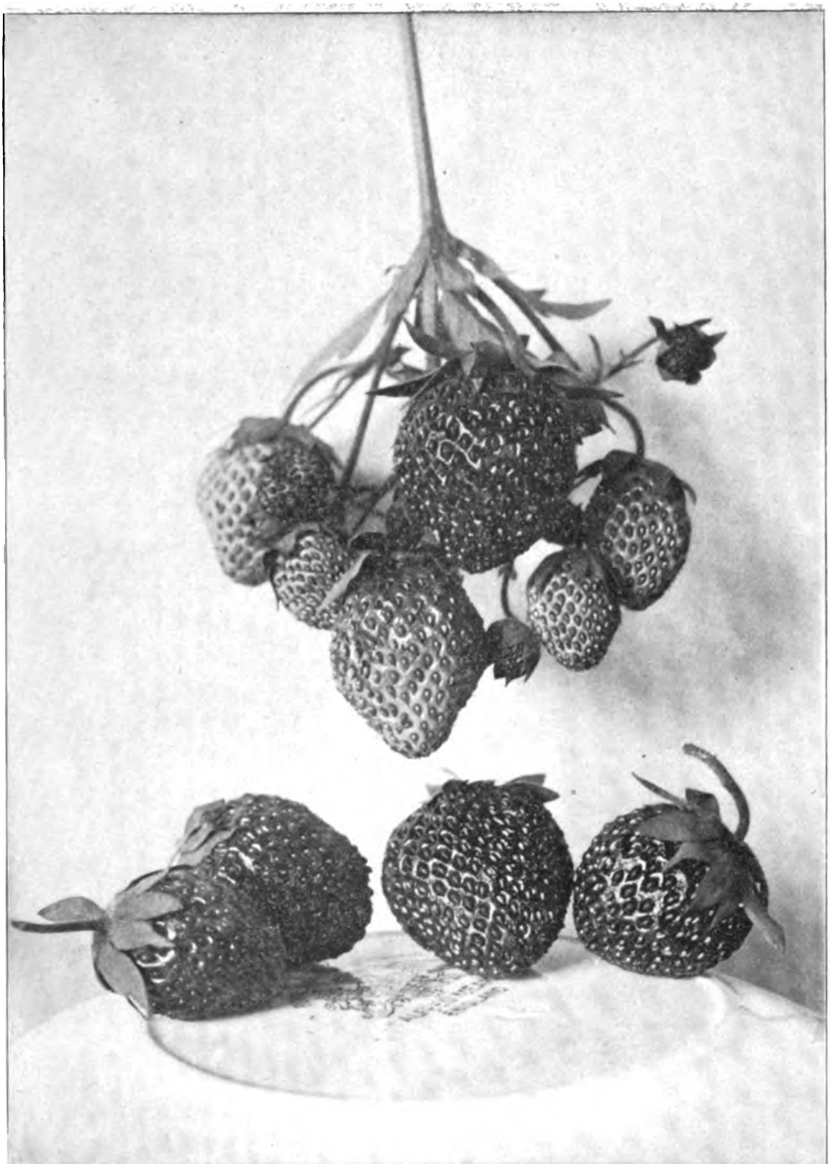
—(16)

out and then only under favorable conditions. The first fruit was produced in 1895. The blossoms withstood heavy late frosts in the spring as well as those of the blackberries or other raspberries. The yield was at the rate of 984 quarts per acre.

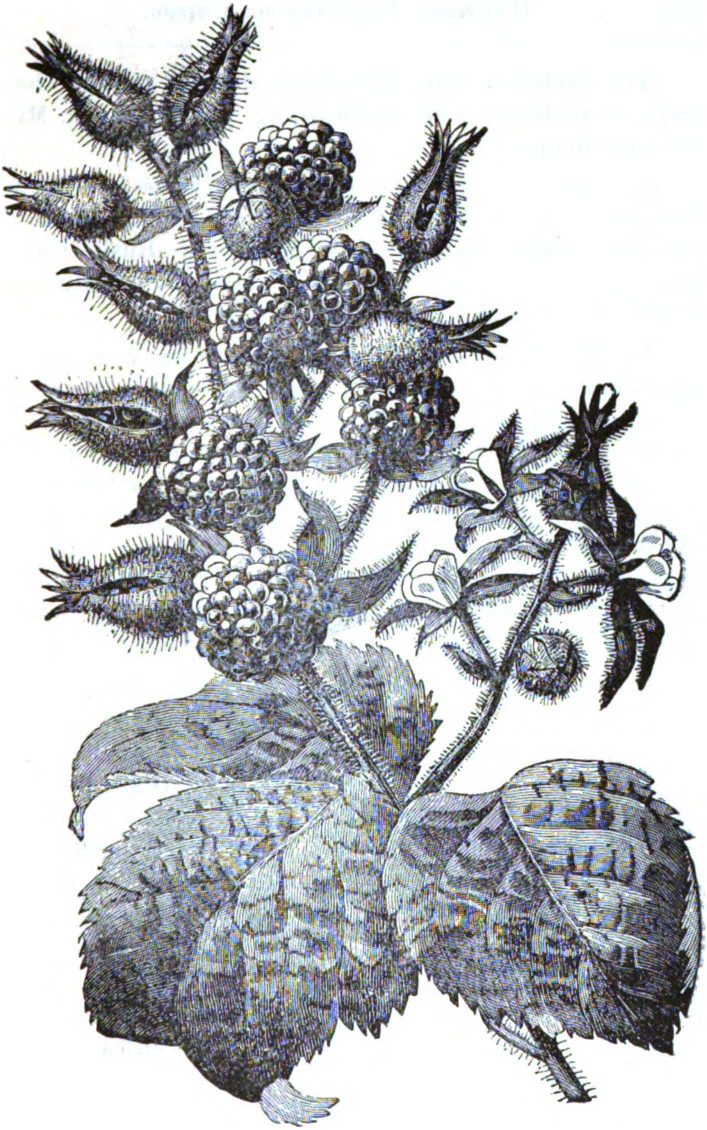
As we stated in "American Gardening" of April 18, 1896, the delicate, juicy, sub-acid berries are most delicious. The calyx of the flower protects them from dust and insects until the time of ripening, when the calyx leaves open and disclose a morsel tempting to the eye and palate. This is very well shown in the illustration of a fruiting branch which we have obtained through the courtesy of the publishers of "American Gardening." We also show a picture of a box of the fruit which was made from one of our own photographs and published in "American Gardening." A few bushes for home use should be planted in a sheltered corner of every garden. They will repay a great amount of care and patience; and the sensation produced by seeing and eating the first berries to ripen will be a pleasant experience to all lovers of the rare and beautiful. The berries are too soft to ship well, but could be produced for local market. The yield produced in 1895 would sell for nearly $300 per acre.

Strawberries.

Thirty-five varieties were planted in May, 1892. Twelve varieties obtained from Peter Henderson were pot grown plants. These were so tender that only a few of each lived the first year. The bed was kept clean in the summer of 1892 by frequent hoeing. In the fall the native fox-tail was allowed to grow up in the bed. This was frosted before the seed ripened and made a very good protection for the strawberries during the winter. Those varieties which did not fruit in 1893 were Prince of Berries, Perry, Jucunda Improved, Edgar Queen, Stevens, Florence, Lovett's Early, Jennings' White, Nectar, and Iowa Beauty.



EDGAR QUEEN STRAWBERRY, Natural Size. Lander, 1897.



FRUITING BRANCH OF JAPANESE WINEBERRY.

(By courtesy of "American Gardening.")

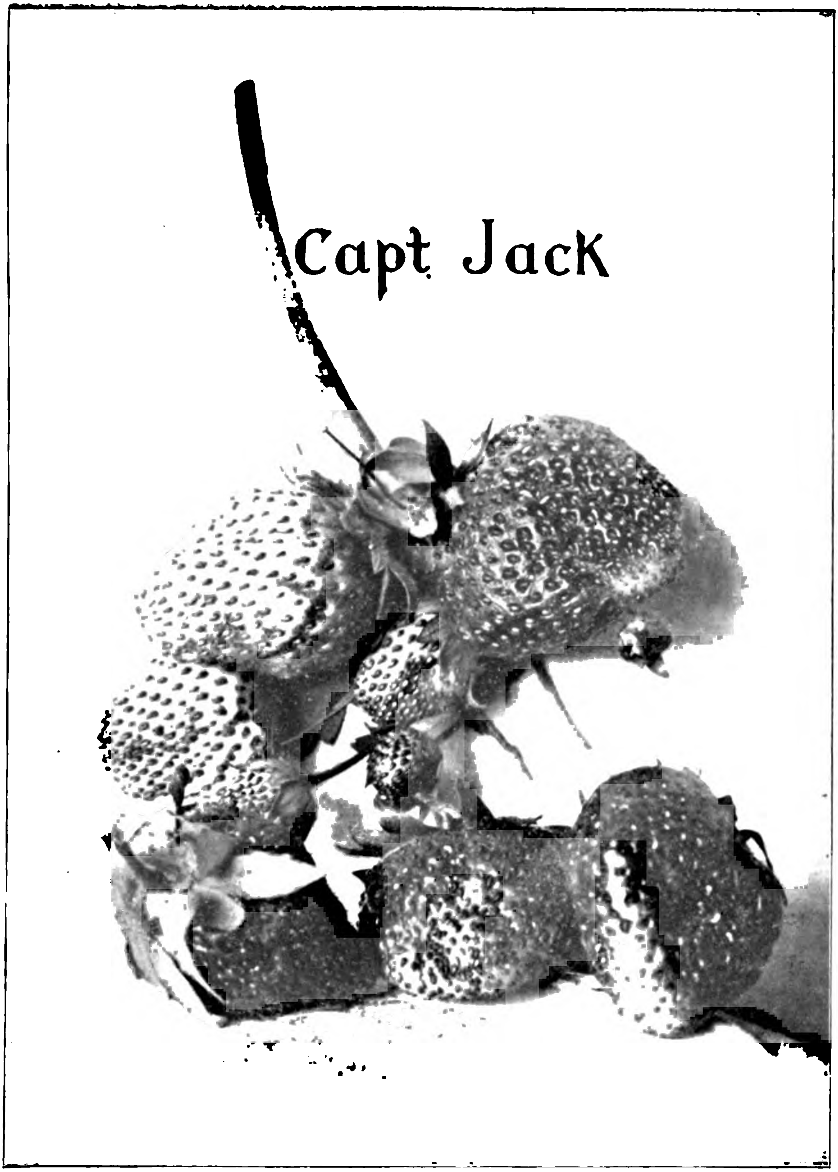
The varieties that fruited but did not produce heavy crops, were Jessie, Charles Downing, Beebe, Ganda, Mitchel's, and Belmont.

The varieties which produced heavy crops in 1893 were Warfield, Bubach, Mammoth, Sharpless, Gold, Cloud, Parker Earl, Shuster's Gem, Wilson, Lady Rusk, Captain Jack, Viola, Bidwell, Triumph, Crescent Seedling, Manchester, Cumberland, and Staymen's No. 1.

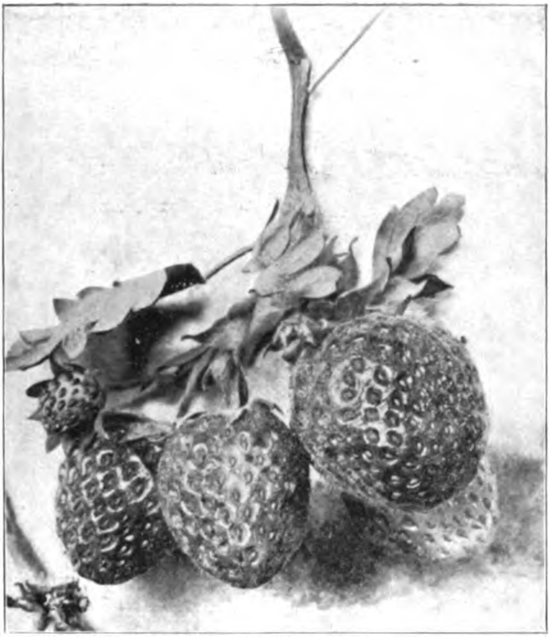
In the winter of 1893 the strawberries were given a light mulch of stable manure. No report upon them is at hand for 1894, as the crickets destroyed nearly everything that season. In the spring of 1895 the blooming and setting of fruit gave promise of a large yield of berries, but the late heavy frosts killed the blossoms and dwarfed the berries which were formed. But few berries matured, and those which did ripen were small and woody. This was true of all varieties. The same strawberry bed was kept over and gave a good crop of berries the past season.

The record for 1897 is given in the table. The yields obtained and the size and quality of the berries show that a strawberry bed may be kept longer than two or three fruiting seasons. However, the accidents that prevented heavy crops of berries in 1894 and 1895 may have left the plants in better condition for a full crop as late as 1897. The table gives the earliness, season, size, shape, flavor, shipping qualities, and productiveness of the varieties that have succeeded best.

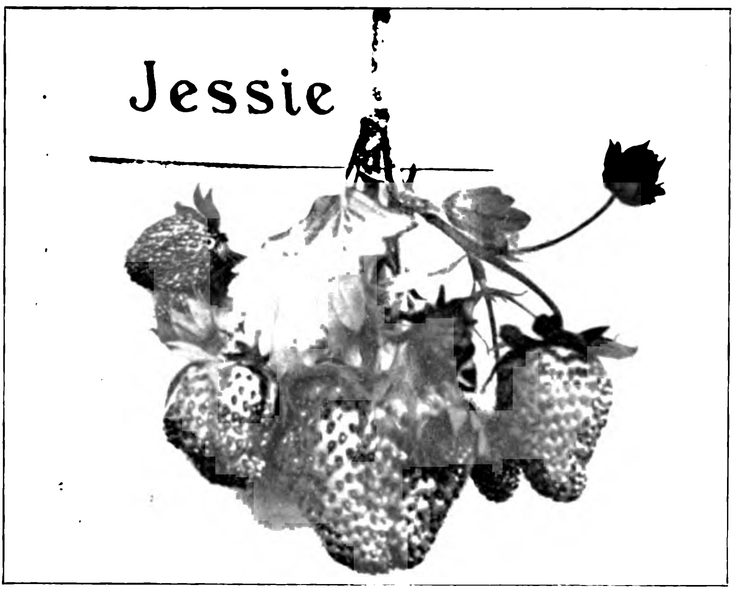
Not enough strawberries are raised to supply the Lander market. This season many crates from other states were shipped to Lander, being carried over 130 miles by stage. They are of such easy culture and succeed so well that no one should send money out of Fremont county for them, nor should they be satisfied with stale, dusty berries shipped from such distances.



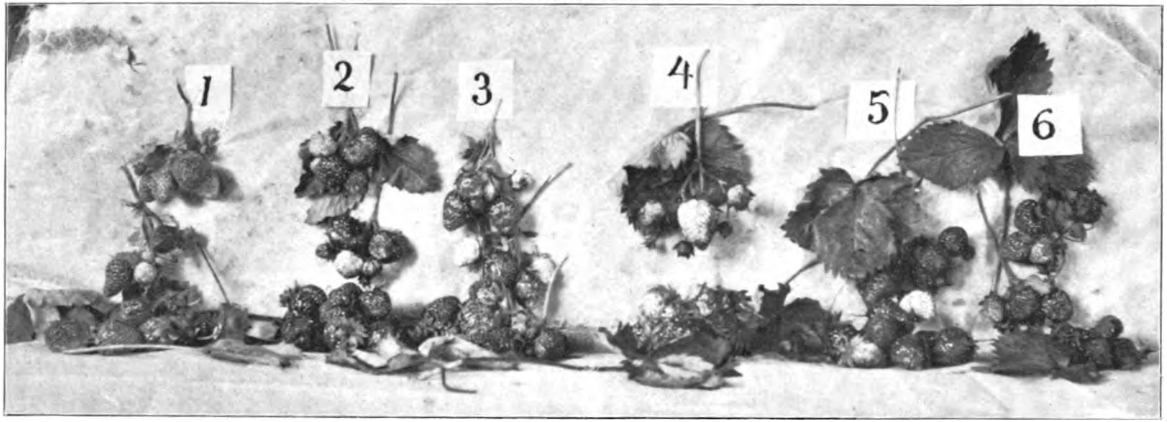
CAPT. JACK STRAWBERRY, Natural Size. Lander, 1897.



BIDWELL STRAWBERRY, Natural Size. Lander, 1897.



JESSIE STRAWBERRY, Natural Size. Lander, 1897.



STRAWBERRIES. Lander, 1897. (One-fifth natural size.)

1, Bidwell. 2, Crescent. 3, Parker Earl. 4, Charles Downing. 5, Cloud. 6, Stamen's No. 1.

Strawberries, 1897.

Variety.	Date of first bloom.	Date first were ripe.	Date last were picked.	Weight of largest twelve.	Diam. of largest berries.	Flavor.	Shape.	Shipping qualities.	Yield per acre
				ounces.	*inches.*				*quarts.*
Mitchel's Early	May 8	June 12	June 22	. . . .	Small	Very sweet	Flat	Good	2784
Crescent	" 8	" 12	July 9	3	1 1-16	Sweet	Bell	Fair	5699
Chas. Downing	" 12	" 15	" 9	3	1⅛	Tart	"	Good	2848
Jessie	" 12	" 14	" 9	3	1⅛	"	"	"	4361
Bubach	" 15	" 16	" 9	2½	1	"	Long, round, blunt	"	4154
Lovett's Early	" 8	" 12	" 9	2½	1	"	Long, round, pointed	Fair	4416
Stephens	" 15	" 15	" 4	2	¾	"	Pointed	Medium	2178
Capt. Jack	" 15	" 15	" 6	2½	1	"	Bell	Good	5555
Jucunda	" 12	" 15	" 9	3	1⅛	Sweet	Round, pointed	Poor	2976
Sharpless	" 12	" 14	" 9	3	1⅛	Sour	Wedge	Good	4640
Crimson Cluster	" 12	" 15	" 9	2	⅞	Tart	Short, round, pointed	"	4750
Bidwell	" 15	" 15	" 6	2	¾	"	Wedge	"	3735
Cloud	" 15	" 16	June 28	1½	¾	"	Pointed	Medium	*
Parker Earl	" 12	" 14	July 4	2	¾	Medium acid	Round, small, pointed	Poor	3568
Edgar Queen	" 12	" 15	" 9	2½	1	Sweet	Round	Good	4530
Perry	" 15	" 16	" 6	1½	⅞	Tart	Round, stubby	Poor	870

*A few nice berries, but no record kept.

FRUIT GROWERS IN FREMONT COUNTY AND THEIR SUCCESS.

Those farmers who have succeeded in fruit raising in the vicinity of Lander so far as we can learn are Mr. R. H. Hall, Mr. J. B. Houghton, Mr. J. S. Meyer, Mr. Nickerson, Mr. F. Nichol, Mr. E. Tweed, and Mr. Ed. Young. We understand that Mr. Hall has been raising small fruits a number of years and has some fruit trees planted. Mr. J. S. Meyer has raised quantities of small fruits and planted quite an extensive orchard which has been bearing for a number of years. We call attention to the illustrations of trees in his orchard, made from photographs taken in 1895. The Duchess apple tree shown has produced heavy crops of very large, perfect fruit for a number of years. Mr. Meyer gives a brief account of his experiments with fruits in the following letter, written September 9, 1897.

Letter from Mr. J. S. Meyer.

"I find from experience that fruit can be grown in the Lander valley at an altitude of 5300 feet, and while we have some difficulties to overcome, the more experience we have, the more successful we will be in getting our orchards to bearing.

"I fully expected that by this time we should be able to determine from trees set out on the Lander Experiment Farm and my own farm such varieties as would be a success here, but unfortunately, September 20, 1895, the thermometer dropped to within 12 degrees of zero, while our trees were in full leaf and the sap up, which resulted in killing all trees that were planted as late as 1893. In my home orchard I lost 50 per cent of trees planted in 1892 and 75 per cent of those set out a year later. My older trees that were planted prior to 1892 were damaged but little, which goes to prove that had we begun planting trees earlier we would today be growing apples in abundance.

I have eight trees that were set out in 1885 which have

OLDENBURG APPLE.

Orchard of J. S. Meyer, Lander, 1895.

not missed bearing the last six or seven years. In no country could they have done better than here; in fact, the trees are always too full of fruit.

The varieties consist of Duchess of Oldenburg,* Wealthy, Briar Sweet,† Soulard Crab, and the Siberian Crab. I have this year apples growing on trees that were planted in 1892 and 1893 of the following varieties that withstood the September freeze of 1895, and are very promising: Wealthy, Duchess, Yellow Transparent, Whitney, Soulard Crab, Martha Crab, Montreal Beauty Crab, the last being the hardiest and most prolific of the crab varieties.

"The following trees put out in the spring of 1893 withstood the freeze of September, 1895, with losses as follows: Wealthy, 15 per cent; Duchess, 30 per cent; Ben Davis, 20 per cent; Yellow Transparent, 30 per cent; Martha Crab, 25 per cent; Soulard and Montreal Crab, 15 per cent. With the small loss of the above varieties we have four standard varieties and three crabs that have been tested and found all right for this climate and altitude, and which I would not hesitate to recommend for planting by anyone who will give them reasonable care.

"I have grown very successfully for a number of years quite a variety of small fruits, viz.: Blackberries, raspberries, gooseberries, currants, strawberries, and grapes. The success with grapes this year on the Lander Experiment Farm is enough to convince anyone that all that is necessary to grow our own grapes is to set them out and give them the attention they need. The following varieties are loaded with fruit: Concord, Wyoming Red, and Delaware. They are grown without difficulty, as they are so easily protected in the winter. Blackberries and raspberries have to be covered with dirt. Strawberries need very little winter protection.

*Called Oldenburg in other parts of this bulletin.
†Also known as Van Wyck.

"In conclusion, I wish to say that it is a matter of only a few years until the Lander valley is growing its own fruit. Only a few days ago I met a neighbor, Mr. Ed. Young, on the streets of Lander with a load of apples of his own growing.

"It has been only a few years since I hauled apples from Holt county, Missouri, to Lincoln, Nebraska, and at that time the people of Nebraska thought they could not grow fruit. Look at the fruit produced there today! Wyoming can do even better, as we have the advantage of irrigation."

Mr. Nickerson, whose farm adjoins the experiment farm on the west, has raised several varieties of apples with success, and now is making a business of raising small fruits. Mr. Ed. Young, whose farm is situated at the mouth of the Little Popo Agie canon, above Dallas, has been very successful with apples. In the fall of 1891 he wrote us that his trees had been overloaded for two years and had not winter killed. We visited his farm in the fall of 1895 and secured some photographs of his trees, one of which is reproduced in this report. In 1894 he had about one hundred trees in bearing of the Oldenburg, Wealthy, Whitney Crab, Great Lakes Siberian Crab, Sweet Russet, and Transparent varieties, marketing that year about 5,000 pounds of apples. The same year he had some De Soto and Rolling Stone plum trees in bearing.

At the time of our visit, Mr. Young had between two thousand and three thousand apple trees, three, four, and five years old, on his place, there being over one thousand Wealthy and large numbers of the following varieties: Tetofsky, McMahon, Wolf River, Hybernal, Oldenburg, Transparent, Sweet Russet, Longfield, Windsor Chief, and Lowland Raspberry. There were also some fine trees of Gakovska and Bessemianka pears, and Early Richmond cherries and Russian apricots. We learn that Mr. Young marketed large quantities of apples in 1896 and 1897.

WEALTHY APPLES.

Orchard of Ed. Young. Dallas, Fremont County, 1895.

SHERIDAN.

The agricultural lands of Sheridan county consist mainly of the valleys along the streams and the adjoining uplands that can be irrigated by ditches taken from these streams. The altitude is lower than that of most parts of the state, much of the land being less than 4,000 feet above sea level. The soil differs from that of the other parts of the state. It is alluvial deposit or clay soil rich in the inorganic plant foods. In places where the drainage is poor the soil contains a large amount of alkali.* The water used for irrigation is very pure when it comes from the Big Horn mountains, but in its course across the lower lands it takes up considerable quantities of salts from the soil. That used upon the experiment farm carries considerable alkali.† The character of the soil and water makes drainage of any land to be used for the production of fruits an important consideration. The fertility of the soil, the low altitude, and comparatively long summer season, the rolling character of the land and the nearness of the Big Horn mountains cause conditions which make fruit raising about Sheridan successful.

Fruits Upon the Experiment Farm.

The experiment farm was established in 1891 and in the spring of 1892 a total of more than one hundred sixty-five varieties of fruits were planted. At that time the trees and plants had to be shipped a long distance by wagon, and much of the stock was en route so long that it arrived in

*See Bulletin No. 6, "Soils of the Agricultural Experiment Farms," page 19, and Bulletin No. 14, "Geology of the Wyoming Experiment Farms," page 112.
†See Bulletin No. 24, "Water Analyses," page 117.

poor condition and did not grow after being planted. However, a few of nearly all varieties were saved, so we are able to report most of them. The fruit plats have a gentle slope toward the west and north.

THE ORCHARD.

The trees in the orchard which lived after being set out and through the first year, made good growth and were in excellent condition in the fall of 1895. In the latter part of August of that year several rains occurred, which caused the sap to increase in the trees, and the sudden storm and freeze of September 20th killed nearly all the young trees. The storm had the same effect as was produced at Lander, older orchards in the county not being injured to so great an extent. Some of the trees were so injured by rabbits during the first two years that they died from the effects.

Apples.

Following is a list, giving the number of each variety planted in the spring of 1892: Four Whitney Crab; four General Grant, four Transcendent Crab, four Martha Crab, ten Hyslop Crab, twelve Oldenburg, twelve Wealthy, twelve Tetofsky, twelve Ben Davis, and six each of Red Astrachan, McMahon, Wolf River, Yellow Transparent, Willow Twig, Early Harvest, St. Lawrence, Wine Sap, Pennock, Lawver, Red Transparent, and Bailey's Sweet.

On account of the condition of the stock when received, the number of each left alive does not indicate hardiness, and is omitted. As the trees died their spaces were filled in by plantings of other varieties, but we have no reports showing just what has been done.

In 1895 the orchard presented a good appearance. The trees were thrifty. General Grant, of which we show a picture of the row of trees, was in bearing. Martha Crab also produced some fruit, and one Ben Davis tree produced a

GEN. GRANT CRAB TREES. Sheridan, 1895.

single apple. A number of trees of each of the following varieties were set out in 1895, having been obtained from G. W. Barlow of Sheridan: Northwest Greening, Yellow Transparent, Pewaukee, Wealthy, Haas, Huntman's Favorite, McIntosh Red. The trees which were killed in the fall of 1895 were all removed the following spring and none have been replaced on the farm since that time.

Cherries.

The following varieties were planted in 1892: Six Ostheim, three Little Phil, six English Morello, three Sport Amorilla (?), six Early Richmond. None of these have been hardy enough to withstand the winters and bear fruit. The roots live, but the tops die down to the ground each year.

Pears.

The pears were not hardy, nearly all of them dying to the ground each winter. Flemish Beauty was the only variety which had made a well formed tree in 1895.

Plums.

Forest Garden, Weaver, Quaker, Wolf, Hawkeye, De Soto, Abundance, Mooney, Blood Golden, Yellow Egg, Green Gage, Toronto, Lombard, and Marianna have been tried. The Marianna, Lombard, Green Gage, and Mooney blossomed and set fruit in 1895, but the late frosts caused them to fall off, so none were matured. Our illustration shows the Mooney plum tree at that time. These varieties seem to be hardy and should be given further trial.

GRAPES.

No grapes have been reported as maturing fruit, though in 1895 good bunches of grapes were formed on Green Mountain and Brighton. The vines were injured by the frost of May 28, 1895. The varieties which have been most hardy are Green Mountain, Brighton, Concord, Delaware, and Martha, in the order named.

SMALL FRUITS.

Blackberries and Dewberries.

The blackberries set out in 1892 were Early Harvest, Wilson Jr., Wilson's Early, Early King, Erie, Lawton, Child's Tree, Lovett's Best, and Early Cluster. Alll the plants of the last four varieties named died the first winter. The following varieties have borne fruit in 1895 and 1896:

SNYDER.—In 1895, this variety came in bloom June 20. The berries were ripe August 10, but the canes were not prolific. In 1896, the canes came into bloom June 15. The berries were ripe August 10. Most of the fruit was eaten by birds and no yields were noted.

WILSON JR.—In 1895, the canes were in bloom June 2. The berries were ripe August 10, but the canes were not prolific. The berries were large and the canes thrifty. The canes are very thorny, and while they have a trailing habit they are not more easily handled and covered for the winter than other varieties. In 1896, the canes came into bloom June 15, and the berries were ripe August 10.

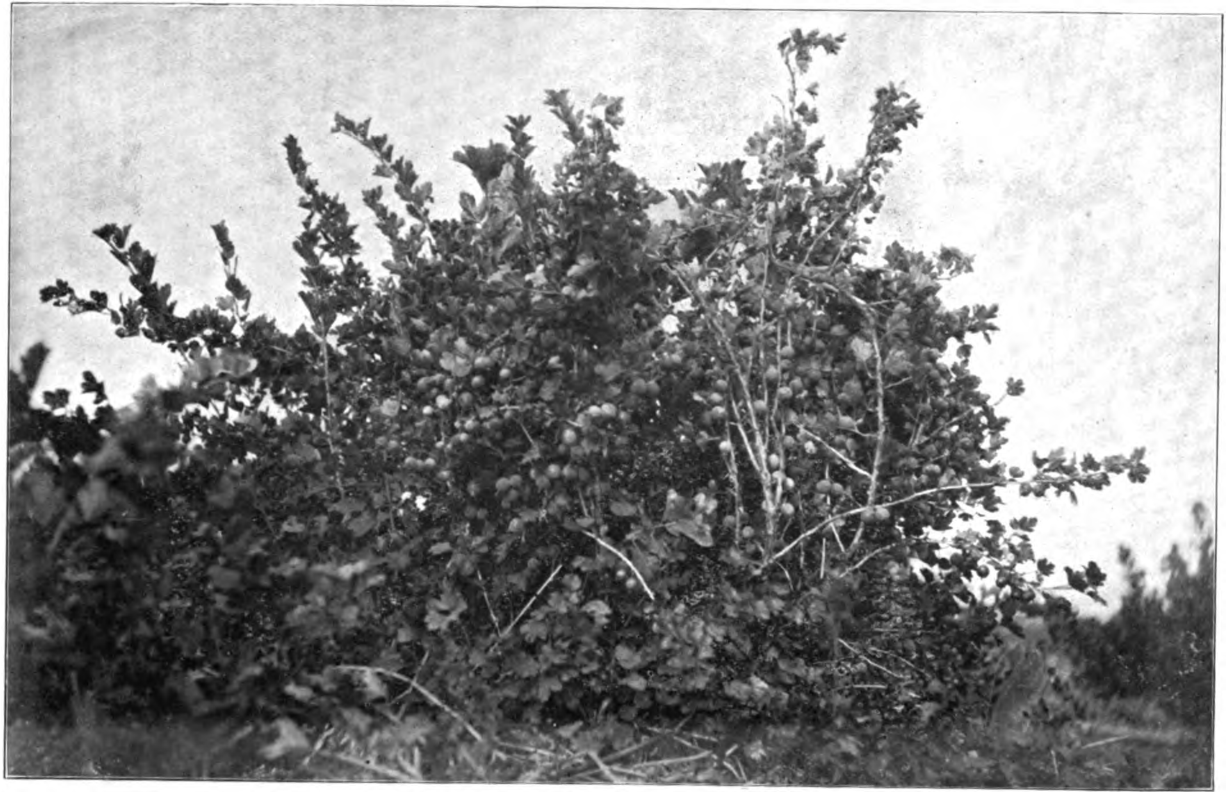
EARLY KING.—This is the best variety tried. In 1895 it came into bloom June 1, and the berries were ripe August 5. The canes are hardy and prolific bearers, the berries large and of excellent quality. In 1896, this variety was in bloom June 15, and the berries were ripe August 10.

MAMMOTH DEWBERRIES.—This variety was only reported in 1895. They bloomed June 2 and were ripe August 1. This was the most prolific dewberry in 1895, yielding at the rate of about 2,000 quarts per acre.

LUCRETIA DEWBERRY.—The canes were in bloom June 2 and the berries were ripe August 1 of 1895, when they bore a heavy crop.

Currants.

All the varieties are hardy except Ruby, which has not succeeded well. The best varieties are Red Cherry and



INDUSTRY GOOSEBERRY. Sheridan, 1895.

White Grape. Lee's Prolific has borne well, but we think Crandall the best black variety.

Currants, 1895.

Variety.	Date of bloom.	Date first ripe.	Yield per acre, gallons.
Red Cherry	May 1	July 25	3120
Fay's Red	" 12	" 20	. . . . .
Ruby	" 12	" 20	. . . . .
Crandall	" 10	" 20	3360
Lee's Prolific.	" 7	" 28	2290
White Grape	" 5	" 25	3120

Currants, 1896.

Variety.	Date of bloom.	Date first ripe.	Dates of pickings.	Yield per acre, gallons.
Red Cherry.	May 12	July 1	July 2 to 20	1900
Fay's Red	" 12	" 7	" 7 to 20	570
Ruby.	" 10	" 1	" 1 to 20	. . . . .
Crandall	" 8	" 20	" 20 to 30	1995
Lee's Prolific	" 10	" 6	" 15 to 20	1567
White Grape	" 14	" 6	" 7 to 20	544

Gooseberries.

Industry and Downing produced fruit in 1894, ripening from July 1st to 12th. The Downing was more prolific and better in every way than the Industry. The following tables give the results in 1895 and 1896. Our illustration shows the character of the Industry gooseberry, the limbs being raised to show the fruit. Golden Prolific has little merit. We recommend Downing for general planting.

Gooseberries, 1895.

Variety.	Date of bloom.	Date first ripe.	Yield per acre, gallons.
Industry.	May 1	July 20	600
Downing.	" 2	" 10	1800
Houghton	" 7	" 20	1500
Golden Prolific	" 4	. . . . .	. . . . .

Gooseberries, 1896.

Variety.	Date of bloom.	Date first ripe.	Dates of pickings.	Yield per acre, gallons.
Industry	May 10	Aug. 1	Aug. 1 to 30	2775
Downing.	" 13	July 20	July 20 to Aug. 30	3800
Houghton	" 14	Aug. 5	Aug. 5 to 25	2385
Golden Prolific	" 14	" 10	. . . .	. . . . .

Raspberries.

As the raspberries have succeeded so well it is regretted that the varieties were so mixed when set out that the work with them cannot be reported as an accurate variety test. Since they began to bear fruit, however, the varieties have been located and reported upon in such a way that at least a part of them are comparable, and the yields and other notes given in the table for the season of 1895 indicate which have proven of greatest value. In 1894, the red varieties which produced the most fruit were Hansel, Brandywine, Cuthbert, and Turner. Of these, the Brandywine, Cuthbert, and Turner were the most prolific and best.

Of the yellow sorts, Caroline and Golden Queen were prolific, the first being of excellent quality.

The black varieties which produced the largest crops were Kansas and Progress, the Kansas being the most prolific.

In 1895, the raspberries produced excellent crops. In the following table we include only those varieties which were not badly mixed in the rows, and their comparative earliness and productiveness is indicated. The Shaffer is a purple berry rather than black.

Variety.	Date in bloom.	Date ripe.	Yield per acre, quarts.
RED—			
Hansel	May 29	July 20	1080
Brandywine	" 29	" 20	1680
Early Prolific	June 12	" 25	1440
Marlboro	" 16	" 20	....
YELLOW—			
Golden Queen	" 1	" 20	960
Brinkle's Orange	" 15	" 30	1080
Caroline	" 15	" 30	720
BLACKCAPS—			
Gregg	" 2	" 25	780
Shaffer	" 1	" 30	600
Lovett's Black	" 5	" 30	1220
Kansas	" 5	" 30	720

The superintendent reported that 50 per cent of the red varieties and 80 per cent of the black caps were killed by

TURNER AND MAMMOTH CLUSTER RASPBERRIES. **Sheridan, 1896.**

(Photo by Trone.)

the storm of September 20, 1895. The yields were comparatively small in 1896. The varieties being mixed, we cannot report all of them, as the results cannot be depended upon where the varieties reported are not true to name. The following three red varieties are the only ones upon which the data is sufficiently accurate.

HANSEL.—The canes were in bloom June 15 and the first berries were ripe July 10. They were harvested from July 15 to 28, and yielded at the rate of 886 quarts per acre.

BRANDYWINE.—This variety came into bloom June 17. The first berries were ripe July 13. They were harvested from July 15 to 28, and yielded at the rate of 555 quarts per acre.

CUTHBERT.—The canes were in bloom June 18. The first berries were ripe July 10. They were harvested from July 15 to 26, and yielded at the rate of 887 quarts per acre.

Other varieties which produced good crops were Lovett's Best, Kansas, Brinkle's Orange, and Marlboro. Marlboro is reported as mixed with Japanese Wineberry, but as the latter has never borne fruit at Sheridan we report the yield given for Marlboro. While not quite so early as Hansel, Brandywine, or Cuthbert, the Marlboro produced the heaviest crop of any berry reported in 1896, the yield being 1425 quarts per acre. We show illustration of two varieties of raspberries at time of harvest in 1896.

Cost and Profit.

The yields computed by Superintendent Lewis for the two seasons, 1895 and 1896, give an average from all varieties grown of 953 quarts per acre. The market price was 25 cents per quart, giving an average value of $238.25. Mr. Lewis estimated the cost of picking at two cents per quart, but we think this too low. We believe five cents per quart would be a fair estimate of the expense of boxes, and picking and crating the berries. Mr. Lewis estimates the cost of

raising an acre of raspberries at $18. This, with the total expense of picking and marketing the berries would make the cost per acre $65.65. It must be remembered that the estimate of yield given is an average of a large number of varieties, among which are many kinds which are very poor yielders, and any one raising a few of the better kinds would obtain much greater yields.

However, this low average gives the following profit:

Average yield per acre of all varieties for two years 963 quarts—value in local market............	$238.25
Total cost, including picking and marketing the crop	65.65
Net profit per acre..................	$172.60

STRAWBERRIES.

Sixty-two varieties of strawberries were set out, but not all of them succeeded, as the pot-grown plants were too tender, and all died after being transplanted. The plants were set so far apart that they did not form matted rows until after the crop of 1894. They were planted eighteen inches apart in rows five feet apart. The table for 1894 gives the record as furnished by the superintendent.

In 1895 all the varieties bore a few berries but the frosts of May 15, 16 and 28 killed the larger part of the blossoms. Otherwise there would have been a heavy crop. No weeds were allowed to grow in the bed and the most of the varieties produced thickly matted rows, some of them being five feet in width. The earliest varieties to ripen were Lovett's Early and Warfield, and those which were most prolific and of best quality were Gandy, Warfield, Jucunda Improved, Lovett's Early, Iowa Beauty, Eureka, Mitchel's Early, Cresent, Haverland, Jessie, Cumberland, and Manchester. In 1893 the Eureka produced large fruit, a single berry measuring seven inches in circumference and weighing two ounces. In 1894 the Eureka and Gandy produced large berries, six berries of each being found which meas-

NEW STRAWBERRY BED. **Sheridan, 1896.**

(*Photo by Trone.*)

ured six and one-fourth inches in circumference. In 1896 the old strawberry bed gave larger yields from the different varieties and the data is given in the table for that year. A new bed was planted in 1896 of which an illustration is given.

Strawberries, Sheridan, 1894.

Variety.	Date of first bloom.	Date first ripe	Yield from 6 hills. quarts.	Remarks
Jessie		July 1	3.5	
Hart's Minnesota		" 2	....	
Mitchel's Early		June 25	4	
Miner's Prolific		.....	....	
Crescent		" 27	5	
Old Ironclad		July 29	2.5	
Manchester		" 4	2.5	
Great Pacific		.....	....	
Lady Rusk		June 30	4.5	
Bidwell	June 10	....	....	Tender; winter kills.
Cumberland	" 8	July 7	3.5	Large, smooth, solid.
Crawford	" 10	" 6	....	Not good
Sharpless	" 12	.....	....	Not hardy
Capt. Jack	" 12	" 9	4.5	Hardy; prolific.
Bubach No. 5	" 15	" 12	....	Tender; poor.
Gandy	" 9	" 7	4	Vines tender; fruit fine.
Eureka	" 9	" 1	4	Fruit large; rough.
Haverland	May 30	June 28	....	Poor.
Monmouth	.....	.....	....	Tender.
Wilson	June 7	July 1	4	Prolific.
Warfield	" 1	June 25	5	Hardy and prolific.
Stayman's No. 1	" 7	July 3	2.5	Fruit soft; thrifty.
Stevens	.....	.....	....	Winter kills.
Shuster's Gem	" 20	" 10	2.5	Fruit fine; plants tender.
Iowa Beauty	" 12	" 10	2.5	Fruit small; plants hardy.
Viola	.....	.....	....	Winter killed.
Florence	.....	.....	....	Winter killed.
Jucunda Improved	" 4	" 2	3	Fruit fine; plants hardy.
Yale	.....	.....	....	Not good.
Standard	.....	.....	....	Winter killed.

Cost and Profit.

An estimate of the cost and profit from an acre of strawberries at Sheridan for 1896 may be of interest. The thirty-one varieties which gave yields large enough to be recorded produced an average of 6,920 quarts per acre. The prices ranged from 10 to 15 cents per quart. Taking the lowest price, all varieties, good, bad, and indifferent, would have an average value of $692 per acre. The superintendent's estimate of the cost of raising an acre of strawberries is $93. We think this would set out a new acre to the very best plants every year, allowing $4 per thousand for the plants.

—(20)

Three cents per quart would be a liberal estimate of the cost of picking, boxing, crating, and hauling to market, or a total of $208.60 per acre. These figures would give the lowest probable profit. A few of the better varieties would give much better yields, and we have allowed a liberal amount for expense.

Average value per acre of crop from thirty-one varieties at 10 cents per quart	$692.00
Total cost, including picking, setting out new beds each year, etc	301.60
Net profit per acre	$390.40

Strawberries, Sheridan, 1896.

No.	Variety.	Date in bloom.	Date frosted.	Character of plant.	Date first ripe.	Date last ripe.	Shipping qualities.	Yield per acre, qts.
1	Hart's Minnesota	May 22	May 20	Large	June 20	July 13	Good	7480
2	Jessie	" 29	" 20	"	" 23	" 13	"	3740
3	Mitchel's Early	" 20	" 20	Thrifty	" 20	....	....	None
4	Miner's Prolific	" 25	None	Small	" 28	" 13	"	3740
5	Crescent	" 26	"	Large	" 20	" 13	"	6035
6	Old Ironclad	" 24	"	"	" 22	" 13	....	6455
7	Manchester	" 28	"	"	" 28	" 16	"	5610
8	Lady Rusk	" 19	May 20	"	None	....	....	None
9	Bidwell	" 19	" 20	Very tender	"	....	....	"
10	Cumberland	" 25	None	Large	June 20	" 13	"	7480
11	Crawford's No 1	None	"	Small; poor	None	....	....	None
12	Sharpless	May 26	"	Large	June 25	" 13	....	7905
13	Capt. Jack	" 26	"	Short, stocky	" 24	" 13	"	9350
14	Bubach	" 30	"	Large	" 24	" 12	"	6035
15	Gandy	" 27	"	"	" 23	" 14	....	9350
16	Eureka	" 23	"	Weak	" 21	" 13	....	7480
17	Haverland	" 23	"	Large	" 21	" 13	....	8415
18	Monmouth	" 23	"	" tender	" 20	" 6	"	9350
19	Wilson	" 24	"	"	" 23	" 8	....	7480
20	Warfield	" 27	"	"	" 28	" 13	....	8415
21	Nectar	" 27	"	Small	" 26	" 6	Poor	1870
22	Gold	" 27	"	"	July 1	" 10	....	2805
23	Prince of Berries	" 26	"	Large	June 22	" 13	....	11220
24	Pine Apple	" 25	"	Small; tender	" 20	" 9	....	4165
25	Parker Earl	" 23	"	Small	" 20	" 9	....	5610
26	Chas. Downing	" 23	"	"	" 25	" 6	....	*
27	Parry	" 23	"	"	" 25	" 6	....	*
28	Dayton	None	"	Tender	None	....	....	*
29	Morley	"	"	....	"	....	....	*
30	Crimson Cluster	May 26	"	Large	June 23	" 12	....	7480
31	Stayman's No. 1	" 25	"	Large; tender	" 20	" 13	....	9350
32	Stevens	None	May 20	....	None	....	....	*
33	Shuster's Gem	May 26	" 20	Large	June 23	" 9	Good	5610
34	Iowa Beauty	" 27	" 20	Short	" 24	" 15	"	6885
35	Viola	" 25	" 20	Small	" 26	" 10	Poor	6035
36	Lovett's Early	" 24	" 20	Tall	" 28	" 13	....	7480
37	Edgar Queen	" 24	" 20	Short	" 28	" 18	....	10285
38	Florence	" 30	" 20	Small	" 28	" 14	"	5610
39	Jucunda Improved	" 26	" 20	Very short	" 23	" 17	Good	11645
40	Yale	" 31	" 20	Tall; tender	" 30	" 9	....	4165
41	Standard	" 27	" 20	" "	July 1	....	....	*

*On account of the very poor stand of these varieties, the yields were not computed.

FRUIT GROWERS IN SHERIDAN COUNTY.

So many farmers in Sheridan county are raising small fruits in their gardens that we do not attempt to give a complete list of names. There are some small orchards in the valleys of the Tongue river, Little and Big Goose, Prairie Dog and Piney creeks, from which we have been unable to obtain reports. We learn that Mr. Duval of Dayton has a producing orchard on Wolf creek. Arthur H. Senff of Kearney, Johnson county, has an orchard of apples, plums, and cherries. Thomas Connolly of Big Red and Dell M. Ray of Banner, are raising apples. M. L. Sawin of Sheridan has raised fruits for a number of years for the Sheridan and Buffalo markets. The letters given below, with accompanying illustrations, explain themselves.

Letter from G. W. Barlow, Sheridan, Sheridan County.

"I have delayed answering your letter, hoping to give you a detailed description of some Sheridan county apple orchards, gathered from personal inspection, but so far I have not been able to get away from my work to visit the different people who are growing apples in this county. That they do grow and produce abundantly is a well demonstrated fact, and in such range of varieties as to insure with reasonable care a supply of choice fruit the year around. With the first summer apples brought into Sheridan that were raised in this county this year there were also brought samples of good apples grown last year and kept till August of this year. Of the varieties grown, I can recall having seen Wealthy, Ben Davis, Pewaukee, Hibernal, Red Astrachan, Duchess, Tetofsky, Yellow Transparent, Gideon, Moscow, Alexander; Crabs—Transcendent, Hyslop, Whitney, Gen. Grant, Yellow Siberian, and other varieties of standards, the names of which I do not now recall.

"The future of apple growing in northern Wyoming appears to be fully as promising as the early history of northern Colorado was in '72 or even later. I see the same

conditions prevail to a great extent, and I hear the same prophecies as to the ultimate success of the business as I did there. Everyone who has seen Colorado lately knows that well up to its northern line apples are growing and producing large crops. We will do as well here in a few years, and I think an important point in this connection is to grow our own trees here in the country where we wish to plant them. They are then used to our climatic conditions, altitude, irrigation, etc., and are free from disease and not injured by long shipments. We have a good start in that direction now and will soon grow all our own trees. With proper selection of varieties, plenty of water, good native grown trees and good care, we can grow all the apples we want and some for other people.

"Small fruits all do well here, strawberries and raspberries especially. There were at least 10,000 boxes of strawberries sold and shipped at Sheridan this season. There are few people who raise raspberries for market, owing to the trouble of covering in winter. I know of one block of red raspberries of an acre and a half that yielded 2,000 boxes in 1896 and this year (1897) about 4,000 boxes.

"The Dwarf Rocky Mountain Cherry (Prunus Bessei) I have grown here for five years. It has never failed to produce fruit abundantly; it is never protected in winter and never winter kills; comes into bearing at two or three years of age and bears every year. The fruit ripens in August, from the middle to the last of the month, and will hang to the bushes till loosened by frost. The yield varies somewhat in different plants and in different seasons. I have picked twelve quarts from a three-year-old bush, but I have made no estimate as to the yield per acre. I set them eight or ten feet apart and like the plan of putting one plant between apple trees where the latter are about 18 or 20 feet apart. I think it would be a safe estimate to figure eight quarts per plant, set eight by ten feet to the acre.

ROCKY MOUNTAIN CHERRY. **Sheridan, 1897.** *Photo by Trone.*
Raised by Geo. W. Barlow.

"I believe we will yet raise an abundance of fruit here in northern Wyoming, which for quality and variety will astonish the oldest inhabitant. I am bending all my energies toward finding the hardiest and most desirable fruits for this country. I am anxious to keep in touch with all who are engaged in any horticultural pursuits, and will always do what I can to further horticultural interests in our state. I realize that this state is years behind other new states in horticultural advancement, and I would like to see a more general interest taken in matters of this kind. I believe there is a growing disposition among our residents to try fruit raising, where a few years ago it was taken for granted that 'Wyoming will never be a fruit country.'"

Letter from C. H. Manning. Sheridan, Sheridan County.

"Small fruits, such as currants, gooseberries, and strawberries, do well here. The varieties of strawberries I am growing are Parker Earl, Lady Rusk, Lovett's Early, Mitchel's Early, Wilson, and Gandy. The last-named variety secured the credit for the largest berry in a test inaugurated by the "Sheridan Post." Twenty-nine berries filled a quart box heaping full. Last season I raised some tame cherries, but can not give you the names of the varieties. I put out seven apricot trees in the spring of 1896 which have done extremely well.

"When quality, form, and color are taken into account, my apples will compare favorably with those from any state, and I believe I could compete successfully for size also. I have grown two varieties which have measured 12½ inches in circumference and weighed 15 ounces. I have an orchard of 175 trees which have been grown from root grafts purchased from F. S. Phoenix, Bloomington, Ill. I obtained several varieties to experiment with, some of which have been thrown over the fence. I now claim that I have apple trees that are tougher than our native timber, and I can

grow them where I cannot grow yellow cottonwood. I have the Yellow Transparent, Antonovka, Tetofsky, Moscow, Enormous, and Hibernal, all Russian, and I believe that most of these will bear apples if it freezes from six to ten degrees while they are in blossom. The Moscow and Hibernal will blossom on yearling wood. The Moscow is an early apple, ripening about the 20th of August, and is very nice. Hibernal is one of the best cooking apples. It ripens the last of September. The Antonovka grown in this climate is a most excellent eating apple, as rich and of as fine quality as one could expect anywhere, and I think I can count on a crop five years out of six. Besides the above, I have the Red Astrachan, Wealthy, Wolf River, and Gideon, which are nice eating apples. The trees missed bearing only one year (I think 1892) since they were old enough. This year I sold some apples which had been kept eleven months, that were perfectly good and sound.

"I have a young orchard of 225 trees which I expect will begin to bear next season. They are mostly of the varieties I have named. There are 50 Wealthy, and some McMahon, Switzer, and Plum Cider. The last named is not hardy. The old orchard was planted nine years ago last spring. They were root grafts with one bud above the ground. When two years old they were set out in the orchard, but I think it would have been better had they been transplanted after one year.

"I sold four loads of apples this season. For one load I received five cents per pound, for another load four cents per pound, and for a third load $1.25 per bushel. The only photographs I have of my fruit trees are a couple of Kodak pictures, which do not show the fruit very well, although the trees are breaking down with it. One is of Wealthy and the other of Antonovka apples. I send them to you with the hope that you may be able to use them."

ANTONOVKA APPLES. *(Photo by Trone.)*
Raised by C. H. Manning, Big Horn, Sheridan County, 1897.

WEALTHY APPLES. *(Photo by Trone.)*
Raised by C. H. Manning, Big Horn, Sheridan County, 1897.

SUNDANCE.

The agricultural lands around Sundance have an altitude of between 4500 and 5000 feet. The climate differs from that of other parts of the state principally in the rainfall, which averages about seventeen inches per annum in this section. Irrigation is not practiced. The valleys are well protected by the surrounding mountains, and in these valleys water is found at no great depth from the surface. The soil is red sandy loam containing a large amount of gypsum, but with no gravel or coarse sand. It is almost identical with the soil upon the Lander experiment farm.* The flora of the region differs from that of other parts of the state, as evidenced by the presence of scrub oaks, white birch, and viburnums.

Fruits Upon the Experiment Farm.

The experiment farm was established in 1891, and in 1892 the same varieties of fruits were planted as upon the other sub-stations. A large part of the stock ordered was so long on the road that it did not grow when set out. Good records of the fruits were kept the first year, but the varieties of small fruits were not permanently labeled. Through accidents which usually happen to small labels, they were lost. We have been unable, therefore, to locate the different varieties, and it has been impossible to report the results of the fruit experiments. From the superintendent's notes for 1893 and notes taken by the writer in 1895, we make the following brief report.

*See Bulletin No. 6, page 20, and Bulletin No. 14, page 114.

ORCHARD FRUITS.

Apples.

Of the apple trees set out in 1892, the Wealthy all lived the first year. Fifty per cent of Ben Davis and thirty-three per cent of Gano also lived. The Oldenburg and Yellow Transparent all died. Yellow Transcendent, Whitney, Hyslop, and Martha Crabs lived and made good growth. Notes in 1895 show Wealthy and Ben Davis the most hardy standard sorts. Whitney and Hyslop Crabs were in bearing in 1895.

Cherries.

Early Richmond was most hardy, none of the trees having been winter killed. One Ostheim was in good condition. The tops of English Morello died down to the ground each winter.

Pears.

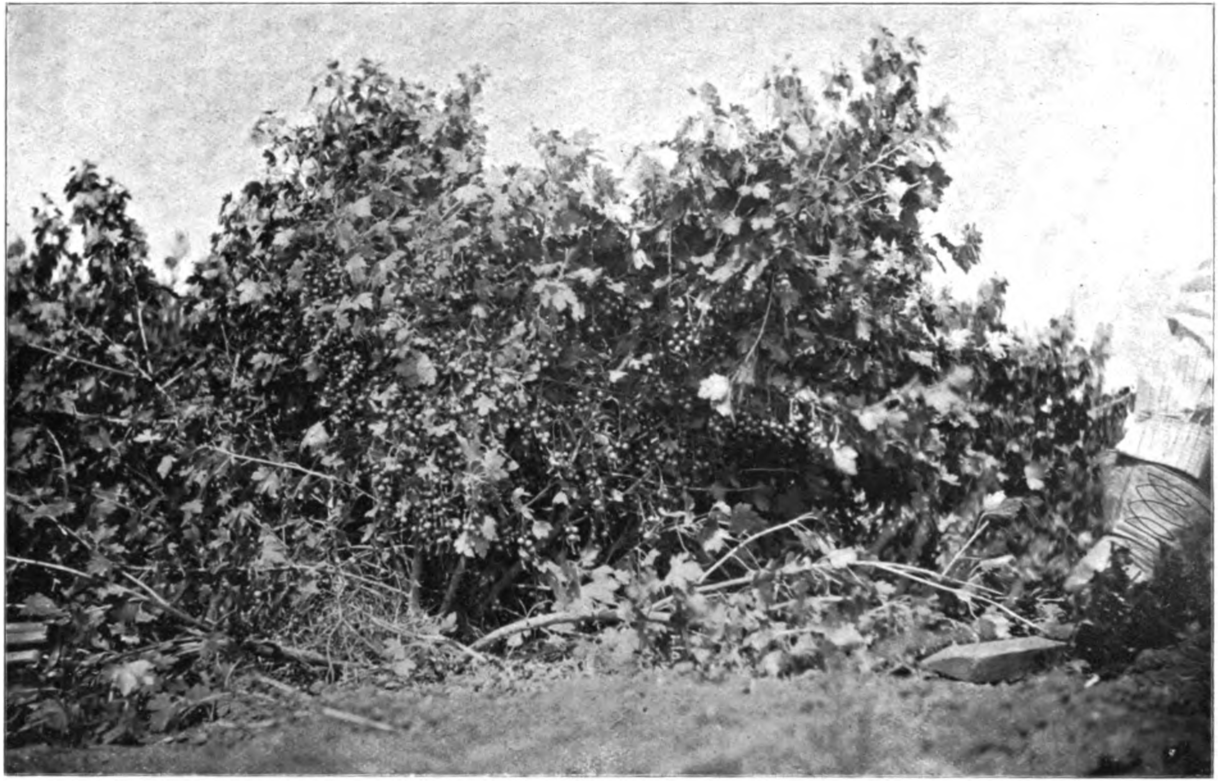
Flemish Beauty pear was most hardy and thrifty, having produced fine trees. Clapp's Favorite was second in hardiness but made rather slow growth. Bartlett, Keiffer, Gakovska, and Bessemianka died down to the ground each winter.

Plums.

Weaver and De Soto plum trees seeemed most hardy, there being good, stocky trees of each variety. One Hawkeye plum tree was in a thrifty condition, the others having made small growth.

SMALL FRUITS.

We are unable to make a detailed report upon the varieties of small fruits. Currants and gooseberries succeeded well and bore heavy crops. The Crandall currant, which we consider the best black variety, was very prolific. We show an illustration of this variety, the limbs being raised to show the fruit. The red and white varieties also bore heavy



CRANDALL CURRANT. Sundance, 1895

crops. The gooseberries do not seem quite so hardy as the currants, but all the varieties bore well. The Downing is the favorite among those tried.

Blackberries, raspberries, and strawberries gave creditable crops, but no records were kept of them.

FRUIT GROWERS IN CROOK COUNTY.

A letter from Hon. A. E. Hoyt states that no one in the immediate vicinity of Sundance has raised any amount of fruit. Mr. Meeks, in the city, has a few fine trees. His Siberian and Transcendent crab trees have borne fruit several years.

Mr. Hoyt states that Mr. J. Eaton of Sand creek has about 150 fruit trees and has raised some fine apples. Mr. Bush of Hulett has about 500 young trees and expected to harvest some apples this season.

We know that with proper care the hardy apples, cherries, and plums, and all the small fruits, will succeed in this part of the state.

WHEATLAND.

The town of Wheatland is at an elevation of 4700 feet and is surrounded by a large tract of fertile farming land.

The Wheatland district is east of the Laramie range of mountains and has much the same climatic conditions as western Nebraska. The soil is colluvial upland and remarkably free from alkali.* The land is irrigated with water taken from the Laramie and Sybille rivers. A large number of farmers have settled upon the lands around Wheatland in the last three years, and many of them are planting orchard and other fruits.

Fruits Upon the Experiment Farm.

The station farm was located in 1891 and fruit plantings begun in the spring of 1892. The farm is on the open plain, and at the time the fruits were planted there was no protection from winds. The trees growing up around the farm have been large enough for two or three years to break the force of the winds to some extent.

ORCHARD FRUITS.

As a rule, the stock purchased was in excellent condition and the loss of trees in the orchard has been remarkably light. In no part of the state have the trees set out in the orchard succeeded better or the outlook been more encouraging than upon the Wheatland farm. The only mishap to the orchard was a hail storm destroying the young fruit in 1896. This season we have been unable to obtain

*See Bulletin No. 6, page 21, and Bulletin No. 14, page 116.

Three Year Old Orchard at Wheatland, 1895. *(Cut loaned by Hon. J. M. Carey.)*

a full report of the fruits, as the farm has not been in charge of the Station. The storm of September 20, 1895, which was so destructive in other parts of the state, caused comparatively little damage to the orchard at Wheatland.

Our illustration of the orchard when it was three years old was kindly loaned to us by Hon. J. M. Carey. The report for 1895, as made by the superintendent, M. R. Johnston, gives the results up to that fall, and Mr. Carey's letter indicates which of the varieties fruited this season (1897). In pruning the trees, care was taken not to remove any branches on the south and west sides, leaving them to protect the trees as much as possible from being burned by the sun.

In the notes for 1895, we copy the record as made by the superintendent in the fall of that year.

Apples.

The trees given in the following notes were planted in April, 1892. In 1895 the mulching was removed from around the trees and tar paper wrapping taken off April 20. The ground was cultivated once a week from April 1 to August 6, being kept in a good state of tilth and perfectly free from weeds. Owing to the thorough cultivation, but little irrigation was necessary, and they were irrigated only twice, May 24 and September 25. The winter protection given was a heavy mulch of coarse manure, and on October 30, 1895, a box made of one by three inch boards was placed around the trunk of each tree to keep the bark from sunscald and injury by rabbits. Before 1895 tar paper was used each winter for the same purpose, but the tar paper proved more or less injurious where it came in contact with the tree.

NOTES FOR 1895.

GANO.—Six trees were planted. All are alive and thrifty. Average diameter of trunks, two and three-fourths

inches. Height of trees, five feet. They came into leaf May 1 and made a season's growth of twelve inches.

BEN DAVIS.—Six trees were planted. All are healthy and in good condition. Average diameter of trunks, two and one-third inches. Height of trees, eight feet. Came into leaf May 1 and made a season's growth of three and one-half feet.

OLDENBURG.—Five trees were planted. Four are alive, with short trunks, and thrifty, bushy tops. Diameter of trunks, two and one-fourth inches. Height of trees, five feet, two inches. They came into leaf May 3 and made a season's growth of fifteen inches.

RED ASTRACHAN.—Five trees were planted. All are alive, strong, and thrifty. Diameter of trunks, two and one-half inches. Height of trees, seven feet. Came into leaf May 3 and had a few blossoms, but fruit fell off when small. Season's growth, twenty-six inches.

WEALTHY.—Six trees were planted. All are alive and thrifty. Diameter of trunks, two and one-half inches. Height of trees, seven feet. Came into leaf May 3 and had a few blossoms, but fruit fell off when small. Season's growth was twenty inches.

YELLOW TRANSPARENT.—Six trees were planted. Five are alive and in excellent condition. Diameter of trunks, two and one-fourth inches. Height of trees, five feet. They came into leaf May 3. Season's growth was fourteen inches.

HYSLOP CRAB.—Five trees were planted. All are alive and very thrifty. Diameter of trunks, two and one-half inches. Height of trees, seven feet. Came into leaf May 3. Season's growth, three and one-half feet.

WHITNEY CRAB.—Six trees were planted. All are alive, strong, and thrifty. Diameter of trunks, two and one-

J. L. BUDD APRICOT TREE. Wheatland, 1895.
(*Cut loaned by Hon. J. M. Carey.*)

fourth inches. Height of trees, six feet, two inches. Came into leaf May 3. Season's growth, forty inches.

MARTHA CRAB.—Six trees were planted . Five are alive and in good condition. Diameter of trunks, three inches. Height of trees, seven feet, two inches. They came into leaf May 6. Had a few blossoms and some apples formed but fell off when small. Season's growth was twenty-five inches.

Apricots.

Variety.	No. set out.	No. living.	Diam. of trunk, inches.	Height, feet.	Came into leaf.	Season's growth, inches.
Abundant*	6	5	2.3	5.2	May 3	14
Gibb†	2	2	3.0	9.0	" 9	24
Alexander	2	2	2.25	10.0	" 9	27
Russian	3	2	1.3	4.0	" 7	13

*Probably Abundance plum.

†Our illustration of this variety was made from a photograph taken in 1895, instead of 1897 as indicated on the plate.

Cherries.

EARLY RICHMOND.—Six trees were planted. All are alive and in good condition. Diameter of trunks, three inches. Height of trees, six feet. They came into leaf May 1 and into bloom May 5. Season's growth was fifteen inches. The fruit was ripe July 4. Birds destroyed most of the fruit as fast as it ripened. Fruit large, dark red color, of fine flavor.

MORELLO.—Six trees were planted, all of which are alive and thrifty. Diameter of trunks, two and one-half inches. Height of trees, six and one-half feet. They came into leaf May 1 and into bloom May 7. The season's growth was fourteen inches. The fruit was ripe July 20. Birds destroyed the fruit.

INTORKA.—Three trees were planted. All are alive. Diameter of trunks, three inches. Height of trees, five feet, two inches. They came into leaf May 3 and had a few

blooms May 5, but matured no fruit. Season's growth was thirteen inches.

OSTHEIM.—Three trees were planted. One is living. Diameter of trunk, three inches. Height of tree, five feet. Came into leaf May 5. Had a few blossoms May 5. Fruit ripe July 4. Fruit destroyed by birds.

ROCKY MOUNTAIN.—Three were planted. Two are alive. A small bush with branches trailing on the ground. Height of bushes, twenty-eight inches. Came into leaf May 6 and into bloom May 6. The fruit was ripe August 10. Fruit of large size, black in color, and of fine flavor.

Pears.

Variety.	No. planted.	No. living.	Diam. of trunk, inches.	Height of trees, feet.	Came into leaf.	Season's growth, inches.
Bessemianka	3	2	1.6	6.5	May 15	15
Gakovska	3	3	1.0	4.5	" 3	13
Flemish Beauty	6	5	2.0	6.0	" 6	18
Keiffer	6	4	1.5	6.0	" 9	17
Clapp's Favorite	6	6	2.25	6.5	" 9	14
Bartlett	6	5	1.0	4.5	" 3	13

Plums.

HAWKEYE.—Six trees were planted. All are alive, and have made large, healthy trees. Diameter of trunks, three inches. Height of trees, seven feet, two inches. They came into leaf May 3 and were in blossom April 27. The season's growth was fourteen inches. The fruit was ripe August 26. The trees yielded two quarts each.

DE SOTO.—Six trees were planted. Five are alive and in good condition. The average diameter of the trunks is two inches. The height of the trees is eight feet. They came into bloom April 27, and into leaf May 3. The season's growth was twelve inches. The fruit was ripe August 30, the yield being six quarts. Fruit was not so good as that of Hawkeye.

WOLF.—Six trees were planted and all are alive and

ENGLISH MORELLO CHERRY IN BEARING. Wheatland, 1895.

thrifty. The average diameter of the trunks is three inches and the average height of the trees is seven feet, one inch. They came into leaf May 9. The season's growth was twelve inches.

SMALL FRUITS.

The small fruits have not succeeded so well as the trees, a much larger per cent of the plants set out having died. This is explained by the fact that the orchard was set out on a more favorable part of the farm. With the small fruits the winds of winter and early spring dried out and blew away the soil and whipped off the plants. They were all set out in April and May of 1892. Those which died have not been replaced, and there are undoubtedly many varieties in addition to those here reported which will succeed. However, those which we report as fruiting best are probably the most hardy and prolific of the kinds tried. All have been grown under the same conditions and have been treated as nearly alike as possible. Our report is based upon the superintendent's notes for the season of 1895. Those varieties of which all the plants died before that season are not mentioned.

None of the grapes succeeded. The dewberries are not mentioned in the report for the year. The small fruits were given clean cultivation with a horse cultivator and hoed each month during the summer. All were irrigated in furrows between the rows. The currants, gooseberries, raspberries, and blackberries were irrigated May 20, June 10, June 22, July 12, August 1, and September 28. The currants and gooseberries were protected through the winter with a heavy mulch of barnyard manure. The other fruits were laid down and covered with earth. The mulch was removed about the middle of April.

Currants.

WHITE GRAPE.—Twenty-four were planted . All lived. They came into leaf April 15 and into bloom May 3.

The fruit was ripe July 6. The yield averaged two and one-half pounds per bush or at the rate of 9075 pounds per acre where planted three by four feet apart. Fruit large and of excellent quality.

RED CHERRY.—Twelve were planted and all lived. They came into leaf April 15 and into bloom May 1. The fruit was ripe July 25. The average yield was four pounds per bush or at the rate of 14,520 pounds per acre. Berries small, light red, of excellent quality.

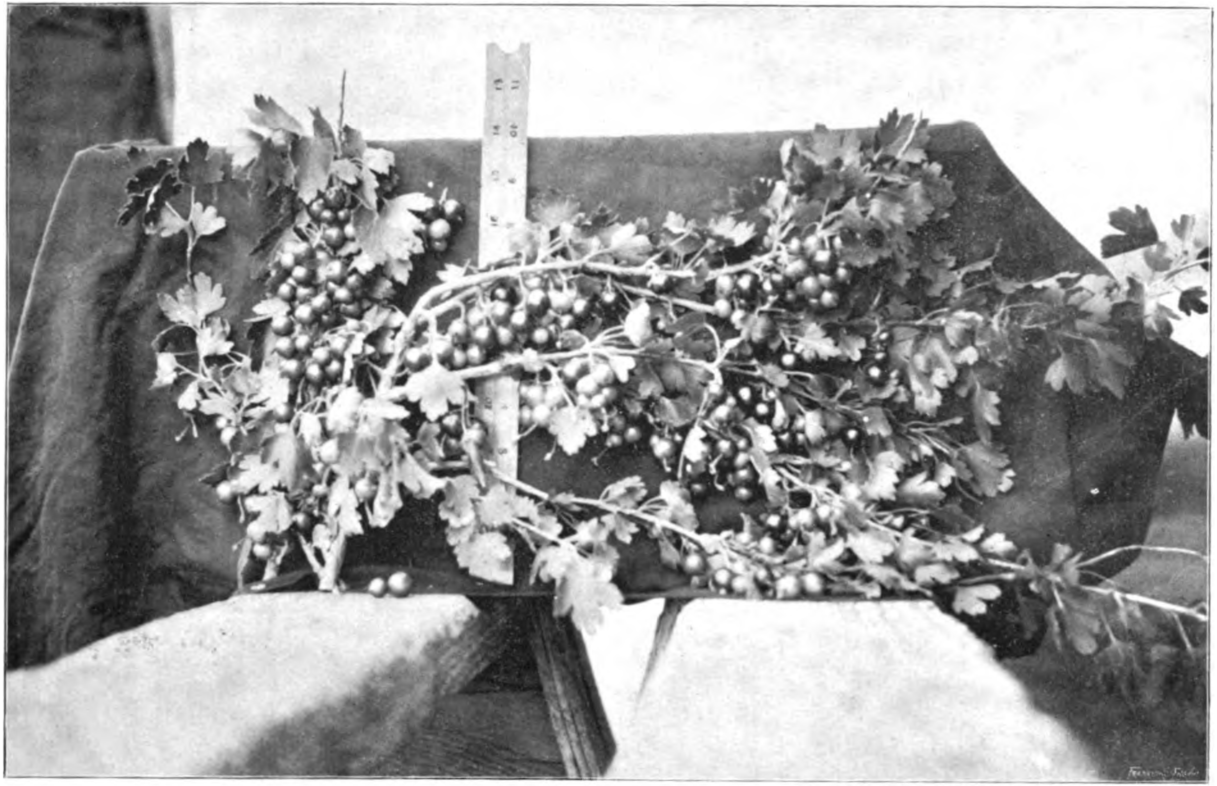
CRANDALL.—Twelve were planted, all of which are living. They came into leaf April 15 and into blossom May 1. The fruit was ripe July 10. Yielded an average of nine pounds for each bush, or at the rate of 32,670 pounds per acre. The bushes are very thrifty and prolific. Fruit large, black, and of good flavor.

LEE'S PROLIFIC.—Twelve were set out. Ten plants are living. They came into leaf April 15 and into bloom May 4. The fruit was ripe July 17. The yield averaged two and one-half pounds per bush, or at the rate of 9,075 pounds per acre. The fruit is black, of medium size, and poor quality.

Gooseberries.

DOWNING.—Twenty-four plants were set out. All are alive. They came into leaf April 24 and into bloom May 8. The fruit was ripe July 23. The average yield was six pounds per bush, or at the rate of 21,780 pounds per acre. Berries large, light green, of fine flavor, flesh soft; a prolific cropper.

HOUGHTON.—Twelve plants were set out. All are living. They came into leaf April 15 and into bloom April 26. The fruit was ripe July 20. The average yield was four and one-half pounds per bush, or at the rate of 16,335 pounds per acre. Fruit of medium size, flavor very fine; a good cropper.



CRANDALL CURRANT. Wheatland, 1895.

Blackberries.

Stone's Hardy, Lawton, Lovett's Best, and Rochester did not bloom. These are named in the order of their apparent hardiness, the most hardy standing first.

EARLY KING.—Twenty-four plants were set out, all of which are alive. They came into leaf May 5 and into bloom May 25. The fruit began to ripen July 15 and yielded an average of three and one-half pounds per hill, or about 9,529 pounds per acre. The berries are large and of excellent quality. This is the best variety tried.

WILSON JUNIOR.—Twenty-four plants were set out. Fifteen are alive. They came into leaf May 3 and into bloom May 18. The fruit was ripe July 10. The berries are large and of good quality . The canes are large and thrifty, but not prolific.

Raspberries.

Golden Queen, Caroline, Brandywine, and Marlboro failed to bloom. Hansel came into bloom May 20 and Progress May 21, but they failed to mature fruit.

THOMPSON'S EARLY PROLIFIC.—Twelve were planted, ten of which are living. They came into leaf May 1 and into bloom May 20. The fruit began to ripen July 1 and yielded an average of two and one-half pounds per hill, or at the rate of about 6,806 pounds per acre. This is the only variety which produced fruit in 1895.

Strawberries.

The first strawberry plat was set out in May, 1892. It was in an unfavorable place and the vines made little growth during the three seasons that the bed was allowed to remain. On May 23, 1895, the young plants were taken from this plat and set in a new bed. No report has been obtained upon them since that time. Haverland has not been hardy. Other varieties which have succeeded best are Manchester,

Jucunda, Mitchel's* Early, Wilson, Florence, Lady Rusk, Charles Downing, Staymen's, Edgar Queen, Stevens, Shuster's Gem, Standard, Warfield, Pine Apple, Parker Earl, Crimson Cluster, Gold, and Crescent.

FRUIT GROWERS IN LARAMIE COUNTY.

Farmers around Wheatland are planting orchards and other fruits. These plantings are new, and but few of them have come into bearing. M. R. Johnston had raised some small fruits there before the station farm was established. Upon the Mule Shoe and the Two Bar ranches, west of Wheatland, some apples and other fruits have been produced. A number of people in Cheyenne are growing hardy apples and other fruits in their yards. Mr. John Gordon of Lower Horse creek sent us specimens of Oldenburg apples from his ranch this fall which we photographed for this report.

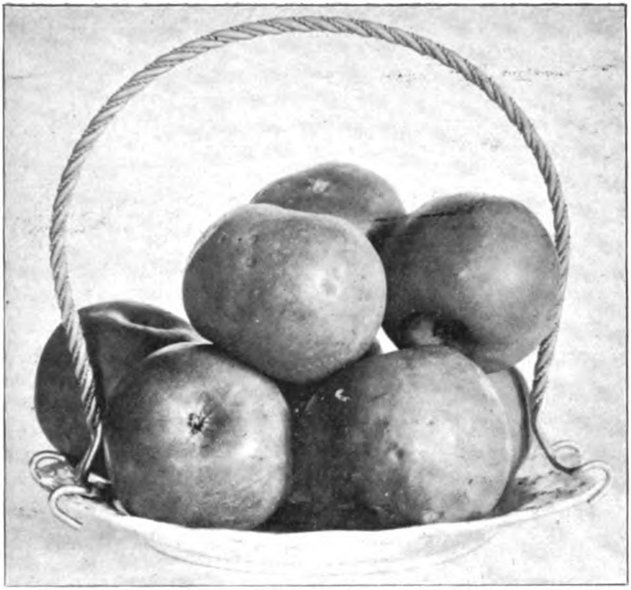
Letter from Hon. J. M. Carey, Cheyenne, Wyo.

"With reference to the fruit, I have to say that twenty odd plum trees of the De Soto and Wolf River varieties, on the land recently used by the University as the experiment farm at Wheatland, bore full crops of fruit. This fruit was of excellent quality. There were fifteen or twenty apple trees that produced fine apples; not full crops, however. These were of the Ben Davis, Wealthy, Northern Spy, and Pippin varieties.

"Mark Johnston says, however, that there were among these fully twenty varieties, the names of which I have not been able to obtain.

"On the Wheatland flats, Mr. Harper produced some fine standard apples of the Ben Davis and Pippin varieties. At the Mule Shoe ranch, several varieties of crab apples were produced in abundance.

*This way of spelling Mitchel's, as given in "Thomas' American Fruit Culturist," is used throughout this bulletin. The favorite spelling is Michel's.



OLDENBURG APPLES, One-Third Natural Size.
Raised by J. N. Gordon, Lower Horse Creek, Laramie County, 1897.

GIBB APRICOTS. Wheatland, 1897.

"There were several parties in Cheyenne who produced apples this year. The mischievous boy, however, prevented very much of the fruit from maturing. Those that were left on the treees grew to a good size and were of fine quality.

"I had about a dozen trees, standard varieties, that produced fine apples, and so far as they were permitted to remain on the trees they matured. I had one tree of improved crab apples which grew to the size of an ordinary peach. The tree had as many apples as it could possibly carry. They matured and were a delicious eating apple. I had several trees of the smaller varieties of crab apples which produced full crops.

"The small fruits did exceedingly well in the Wheatland colony—gooseberries, raspberries, and strawberries. From what I have seen this year, I have no doubt that Wyoming will become a fruit growing state so far as the varieties which are common in this latitude are concerned."

Letter from J. N. Gordon, Lower Horse Creek, Laramie County.

"I have several varieties of apples, but the names have been lost, so I send you a sample by express, and from this you can get an idea of what success people may expect in raising fruit here. I am sorry your inquiry came so late, as I had several varieties, but they are all gone now except the ones I send you. Years ago I saw as fine grapes grown on a ranch close to my place as I have ever seen in the markets of Cheyenne. After nearly thirty years' farming in Colorado and Wyoming, I have arrived at the conclusion that I can raise on my ranch on Lower Horse creek any of the fruits that can be raised in the Cache la Poudre valley in Colorado."

Fruits in Other Parts of Wyoming.

In Weston, Sweetwater, and Uinta counties, practically no attempts have been made to raise any kind of fruit. In Converse county almost no fruits have been raised. Mr. F. Lusk of Lusk has a few apple trees in bearing. We learn that some fruits have been planted in the vicinity of Douglas and in the La Prelle valley. In Natrona county, some farmers in the vicinity of Casper have young orchards set out. W. A. Blackmore of Casper states that he has recently made plantings of apples,plums,graps,and other small fruits. B. B. Brooks states that he has been quite successful with strawberries and other small fruits, and that upon nearly all the ranches in that section small fruits are raised for home use. Mr. J. Milne of Casper has a small orchard.

In Big Horn county there are a few small orchards. With the exception of the following letters, we have been unable to obtain reports from that section.

Letter from J. H. Taylor, Bonanza, Big Horn County.

"There are several small orchards in the Big Horn basin that have borne fruit for several seasons, and of the choicest kinds. I have been in the business only two years and have had more stock than I could get set out each season. From the late arrival of stock in the spring I have lost a good many, but I have an orchard of several kinds of apples, pears, and plums, besides the small nursery stock, which includes fancy shade trees. The main orchard is doing finely and will begin to bear next year. It consists of over four hundred trees. I am satisfied that this country will grow all of the hardy varieties and that the fruit will be of superior flavor and size."

Orchard of Mr. James Cantlin, Ferris, Carbon County, November, 1897.
(Photo by W. C. Knight)

Letter from J. O. Morgan, Jordan, Big Horn County.

"I have tried several kinds of fruits here. All small fruits, such as strawberries, currants, gooseberries, raspberries, and grapes have done well. Many of my first trees of apples, crabs, cherries, and pears have been winter killed. Those farmers located nearer the mountains whose places are 200 or 300 feet higher than mine have raised fine apples, crabs, and plums. Berries do well in all parts of the county. There is quite a variety of native fruits here. I think this will be a good fruit county when we learn how to handle our trees under irrigation."

In Carbon county a number are raising some fruits. The fruits upon the Saratoga experiment farm were not grown long enough to determine what would succeed. J. D. Parker, who was superintendent, states that currants and strawberries have been successful. We show an illustration of the orchard of Mr. James Cantlin of Ferris, which has borne a good crop of apples. We have not learned the varieties. This orchard was set out seven years ago and has not been given much attention. In Rawlins and vicinity, almost no attempts have been made to raise fruits, though in 1895 we learned of some cherry trees in town which were in bearing.

CONCLUSION.

We dedicate this bulletin to the farmers and ranchmen of Wyoming. We have avoided technicalities and have attempted to make this a popular report for the exclusive benefit of our own people. Should it find a wider use than this, we shall be pleased, but we do not expect it. Other

station workers will find no new experiments reported that add to the knowledge of the day, but the bulletin will convey to them an idea of the horticultural possibilities of our great, new state. We have attempted to indicate the present condition of horticulture in the state and point out the success which will attend the careful grower who wishes to raise fruits within our borders. As it is our first bulletin upon this subject, we have reported all the experimental work attempted, whether or not important results were obtained, and have tried to make it representative of the present stage of our fruit industry.

Our photographs are an accurate and important part of our notes and records, and the conclusions to be drawn from them are as important as facts derived from the text. There is no possibility of misconstruing them, and so far as they illustrate any phase of the subject, they have been reproduced for this bulletin. True, we expect them to be more generally read than the written matter and they represent only successes, but the negative results of our experiments are given proper place.

We are hardly in a position to recommend varieties of fruit for a farmer to plant, However, we do not hesitate to name the varieties which we know to be hardy and prolific in our climate. At present it is not a question of whether we like the flavor of Bellflower apples better than that of Ben Davis, but rather whether we prefer the hardy varieties to no apples at all. It is safe to say that all the fruit raised in our state for many years to come will find a ready market at home. The better the quality, the higher the price it will bring.

The time will soon come, if indeed it is not now at hand, when our fruit growers should organize for the advancement of their own interests and for mutual protection. Concerted action from this time forward should effectually prevent insect enemies or fungus diseases from becoming serious pests

in the state. When once such pests obtain a secure foothold, it is not an easy matter to keep them in check. There are many other advantages to be derived from such an organization.

The following kinds and varieties of fruits have proved to be hardy and prolific in sections which represent the larger portion of the state. Apricots and pears have not yet fruited, though the trees of a few varieties seem perfectly hardy. This list includes only varieties which have generally succeeded, and, with the exception of grapes, they may, with considerable assurance of success, be planted in sheltered localities up to an altitude of something over seven thousand feet.

Apples.—Wealthy, Oldenburg, Ben Davis.

Crab Apples.—Siberian, Martha, Transcendent, Hyslop.

Cherries.—Rocky Mountain Dwarf, Morello, Early Richmond.

Plums.—De Soto, Weaver.

Blackberries.—Early King, Stone's Hardy, Wilson Jr.

Dewberries.—Lucretia, Mammoth.

Currants.—Red Cherry, White Grape, Crandall, Lee's Prolific.

Gooseberries.—Houghton, Downing.

Grapes.—Concord, Wyoming Red, Delaware.

Raspberries (yellow.)—Caroline, Golden Queen.

Raspberries (red.)—Turner, Hansel, Thompson's Early Prolific, Marlboro.

Raspberries (black.)—Kansas, Progress, Gregg, Lovett.

Strawberries.—Nearly all varieties are sufficiently hardy. The notes at Lander and Sheridan show which have been earliest, most prolific, of the best quality, and the best for shipping.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

BULLETIN NO. 35.

DECEMBER, 1897.

Mechanical Analysis and Water Content of Wyoming Soils.

BY O. B. RIDGAWAY.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

—(26)

Wyoming Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

President of the University of Wyoming.

FRANK PIERREPONT GRAVES, Ph. D., Litt. D., LL. D.

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Introduction.

The objects of this bulletin are to show the results of a mechanical analysis of some typical soils of Wyoming, comparing them with typical soils from the humid regions; and also to show the moisture content of the soil of the Laramie Experiment Farm during the growing season.

The method used in making the analysis and in determining the amount of moisture in soils in the field are those described in Bulletin No. 4, U. S. Department of Agriculture, Department of Agricultural Soils, 1896.

I am greatly indebted to Prof. B. C. Buffum, Agriculturist of this Experiment Station, not only for having collected the samples of soil from the different experiment farms, but also for the very complete set of notes which he took at the time and kindly turned over to me for use in the preparation of this bulletin. Acknowledgment should also be made of the patient and faithful work rendered by my assistant, Mr. Joseph Orr, without whose aid the work could not have been completed so quickly.

Mechanical Analysis of Soils.

BY C. B. RIDGAWAY.

The soil is generally defined as the loose earth which covers the rocks to the depth of from a few inches to many feet and furnishes most of the nourishment for growing plants. In the Atlantic coast regions that portion of the earth which is cultivated by the plow, and which extends to a depth of from six to twelve inches, is generally termed the soil, while all below that is called subsoil. The reasons for this distinction arise from the fact that the subsoil when first brought to the surface generally proves very unproductive, for a short time at least after exposure, and from the other fact that there is usually a very noticeable difference in color between the two kinds of soil. In the arid regions, however, these characteristics almost entirely disappear, for in many localities no difference in color is to be noticed from the top of the ground to the solid rock, and in many places when the soil has been brought from a depth of twenty and even thirty feet it has often proved as productive as the surface soil of the same region. This peculiarity of the soils of these regions where irrigation is so indispensable is of inestimable importance. Hillocks are leveled and hollows are filled; thus bringing much of the ground, which otherwise would remain barren, under cultivation.

All soils have been formed from rocks by means of various agencies. The chemical action of the different gases in the atmosphere, the mechanical action of freezing

water, wind erosion, water erosion, the roots of plants entering the seams in the rocks and forcing them apart, but especially the great ice plows of the glaciers leveling mountains and filling valleys—all these have been through countless ages, and still are, at work making soil of the solid rocks. In some cases the soil has been formed in place by the decomposition of the underlying rock, but in others it differs materially from the rock upon which it rests. In the latter case very frequently the soil has been brought from a great distance, either by means of glaciers or running water, and deposited in its present position.

It is a fact now generally conceded by most agriculturists, that a soil may have all the chemical elements necessary for the production of good crops, and yet, unless the physical texture is of the proper quality very inferior crops will be obtained. In view of this fact it is now deemed necessary to make both a chemical and a mechanical analysis of the soil in order to arrive at a just estimate of its productiveness and adaptability to certain crops. The object of the mechanical analysis of the soil is the quantitative determination of the coarsesr and finer material entering into its composition. Only soil whose grains are less than two millimeters (1-12 inch) in diameter, called fine earth, is used for this purpose; all over this size is considered coarse gravel, which is incapable of furnishing any nourishment to plants till further disintegration takes place.

Following the method used by the U. S. Department of Agriculture, I have divided the fine earth into these eight classes:

Diameter in millimeters.	Conventional name.
2-1	Gravel
1-.5	Coarse sand
.5-.25	Medium sand

Diameter in millimeters.	Conventional name
.25-.1	Fine sand
.1-.05	Very fine sand
.05-.01	Silt
.01-.005	Fine Silt
.005-.0001	Clay

It has been found by experiment in the Atlantic Coast States, and in fact in most humid regions, that a sandy soil is best adapted to raising truck, heavy loam to wheat, while a stiff clay has been found best suited for grass land. Some have concluded from this now apparently established fact that in all of the unoccupied regions of the west the soil could very readily be analyzed and prospective settlers assured as to the adaptability of certain soils to certain crops. This method of reasoning, however, will not hold for the arid regions, where the farmers depend almost entirely for their water supply upon irrigation.

The adaptability of the stiff clay lands of the east to the raising of grass depends upon the fact of their retaining more moisture near the surface for nourishing the grass roots than any other variety of soil. In the arid regions, however, some of the very best yields of grain and grass have been obtained from sandy soils by the aid of irrigation. From this we infer that every typical region must work out its own typical soils by the aid of chemical and mechanical analyses coupled with actual experiment. One of the main objects of this bulletin is to classify the soils of Wyoming, if possible, under their various types.

Thirty samples of soil were collected from five of the best agricultural sections of the state. After the soil had ample time to air-dry, the contents of the sacks (holding about twenty-five pounds each) were emptied upon a table covered with oil-cloth, and after thoroughly mixing divided into four equal parts. One of these parts was taken as a

sample and all of the lumps pulverized with a rolling pin covered with thick sheet rubber to prevent crushing the grains of sand. The soil was then passed through a sieve punched with round holes two millimeters in diameter, and after all the coarse gravel which remained in the sieve had been washed, dreid, weighed, and its percentage of the soil calculated, the fine soil was placed in large glass jars which were corked and labeled for future use. A subsample weighing 20 grams was afterwards taken and washed into a long glass bottle, such as is used in sterilizing milk, which was filled half full of pure water and securely closed with a rubber stopper. Ten such bottles with their contents were placed in a shaker of my own construction which had a throw of about six inches and made 150 revolutions per minute. The shaker was kept in constant motion from 24 to 48 hours, according to the nature of the soil, by means of a small water motor. The object of this shaking was to disintegrate all the particles of the soil, so that instead of many conglomerates, which would lead to much difficulty, if not to false conclusions, there might remain only separate grains. After the soil had been washed from the bottles into beakers it was carefully examined under a microscope, and if not thoroughly disintegrated hand pestling with a rubber-tipped pestle was resorted to for a short time to complete the work. The soil was then separated into eight grades by the "Beaker Method."

To aid in forming a more correct idea of the relative amount of grains of various sizes entering into the composition of the different soils, samples of the separations of the different grades of material from each of the five experiment farms were placed into small bottles, mounted on cards and photographed. Besides the eight bottles containing soil, two others appear in the illustrations—the ninth showing the amount of moisture contained in the air-dried sample, and the tenth the amount of organic and volatile matter.

Doubtless the contents of the last bottle is somewhat exaggerated, as I have used walnut sawdust to represent the organic and volatile matter.

In taking the samples, all litter was first removed from the surface and then a hole was dug with a shovel to a depth of three feet on three sides of a column of soil about one foot square at the top. This column was afterwards trimmed down with a sharp spade to a size six inches square. The surface soil of this column to a depth of one foot was removed and placed in a sack 6x12 inches, which sack was numbered, labeled, and securely fastened. Immediately below this sample the column was carefully removed from a depth of one foot to a depth of two feet and placed in another sack. In this manner six samples were taken from each of the farms—three of the surface soil and three of the subsoil. The sacks were so numbered that all of the surface soils were marked with odd numbers and the subsoils with even numbers.

Soil from the Wheatland Experiment Farm.

The Wheatland Experiment Farm is situated in the eastern portion of Wyoming on what is knows as the "Great Plains," at an elevation of 4,700 feet. The soil of this farm is a colluvial deposit derived from the Archaean and Pliocene rocks, without any glacial action however, and resting upon a Pliocene conglomerate.*

The ground selected for taking the first two samples was the prairie sod, on which were found growing buffalo grass (*Bulbilis dactyloides* (Nutt) Raf.), three-leafed sedge (*Carex filifolia*, Nutt), and an occasional spear of *Stipa comata*, Trin. The soil was dry and hard to dig (it was dug the 7th of August), but became a little moist at a depth of one foot. Two feet below the surface a bed of cement gravel was found containing stones of granite, orthoclase, labradorite, magnetite, schist, quartz, and lime incrustations on granite. The top soil was of a dark gray color, but became much lighter in color the farther down it was dug. Samples 3 and 4 were taken from a plat which had been cultivated but not fertilized. The plat had been irrigated on May 20, June 15, and July 8, on account of which the samples were quite moist and easy to dig. No gravel was found in these samples. Samples 5 and 6 were taken from a plat which had been both cultivated and fertilized. The plat had received its last irrigation on July 16th, on account of which the subsoil was very wet and stuck to the shovel. The soil was full of lumps which were very difficult to crush with the unaided fingers. These lumps absorbed water very rapidly and became quite soft and plastic. The soil contained about .6 per cent of coarse gravel.

On making a mechanical analysis, the following results were obtained:

*See Bulletin No. 14, page 116.

No. of Sample: Top soil (0–12 in.)	No. of Sample: Subsoil (12–24 in.)	Locality	Gravel (2–1 mm.)	Coarse sand (1–.5 mm.)	Medium sand (.5–.25 mm.)	Fine sand (.25–.1 mm.)	Very fine sand (.1–.05 mm.)	Silt (.05–.01 mm.)	Fine silt (.01–.005 mm.)	Clay (.005–.0001 mm.)	Moisture in air-dried sample	Organic and volatile matter.	Loss.
			Per cent.	*Per cent*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1		Wheatland	1.205	2.155	11.925	20.205	39.010	2.995	2.180	15.400	2.040	2.060	0.825
	2	"	0.915	2.100	10.025	18.360	41.380	2.150	1.205	15.610	2.000	2.160	4.095
3		"	1.975	2.555	10.840	15.220	39.090	3.775	1.625	17 165	1.480	3.260	3.005
	4	"	0.390	0.965	4.940	13.230	49.245	6.305	5.880	11.400	2.000	3.320	2.325
5		"	1.620	2.610	10.205	17.270	36.880	5.165	1.710	17.300	2.620	3.180	1.440
	6	"	0.240	0.745	3.675	6.305	35.360	16.695	13.420	14.280	2.660	3.000	3.050
		Average	1.057	1.855	8.601	15.095	40.161	6.181	4.339	15.192	2.133	2.930	

The crops raised upon this farm and the greatest yield per acre during three years is shown below.

Alfalfa ....8,732 lbs.
Barley ....50 bush.
Bean ....26 bush.
Beet ....43,776 lbs.
Broom corn ....2,240 lbs.
Buckwheat ....28 bush.
Cabbage ....34,362 lbs.
Carrot ....75,240 lbs.
Corn ....48 bush.
Flat pea ....1,545 lbs.
Flax ....14 bush.
Oat ....74.2 bush.
Onion ....93,492 lbs.
Parsnip ....9,854 lbs.
Pea ....17 bush.
Peanut ....1,740 lbs.
Potato ....25,740 lbs.
Rye ....31 bush.
Sweet potato ....3,200 lbs.
Sugar beet ....24,000 lbs.
Turnip ....12,869 lbs.
Wheat ....50 bush.

The following are the average yields per acre for the same time upon the same farm:

Alfalfa ....5,113 lbs.
Barley ....27.5 bush.
Bean ....22 bush.
Beet ....20,800 lbs.
Cabbage ....27,333 lbs.
Carrot ....42,816 lbs.
Corn ....23 bush.
Flax ....9 bush.
Oat ....39.6 bush.
Onion ....60,746 lbs.
Pea ....16.5 bush.
Potato ....6,860 lbs.
Rye ....19 bush.
Sugar beet.........16,330 lbs.
Turnip ....10,725 lbs.
Wheat ....26.3 bush.

During the three years, this farm excelled the other four in producing the best crops of beans and onions, and was second in alfalfa, beets, cabbage and corn. It also ranked first in the average yield of beans and onions.

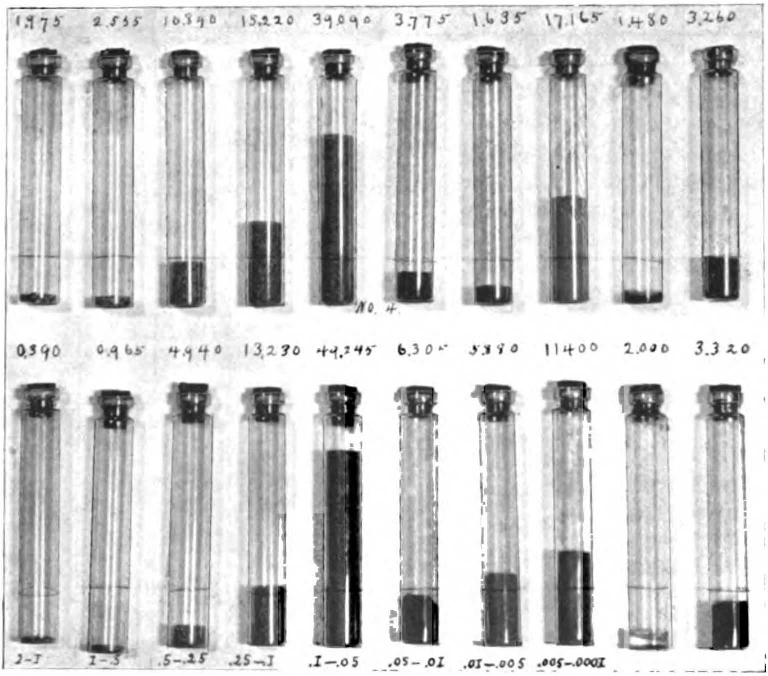
AGRICULTURAL SOILS OF WYOMING.

WHEATLAND EXPERIMENT FARM.

No. 3.

Per cent. of Gravel, Sand, Silt, Clay, Organic Matter and Water in 20 Grams of Soil and Subsoil.

Gravel	Coarse Sand	Medium Sand	Fine Sand	Very fine Sand	Silt	Fine Silt	Clay	Water	Organic Matter



mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.

Diameter of Grains in Millimeter.

Soil from the Sundance Experiment Farm.

This farm is located in the northeastern part of the state, at an elevation of 4,750 feet above the sea level. The soil of the farm has been formed from the Triassic and Jurassic rocks, which are composed of ferruginous sandstone, limestone, clays, and marls. The soil has not been transported any great distance, and in composition and color greatly resembles that of the Lander farm.*

On the prairie sod, where samples 7 and 8 were taken, were found growing blue stem (*Agropyron* sp.), with an occasional bunch of gramma grass (*Bouteloua oligostachya*, Torr). The soil was very dry to a depth of 14 inches and changes color from a dark to a light red. From 14 inches down to a depth of at least three feet the soil was damp and easy to dig. In taking samples 9 and 10, there was found at a depth of 20 inches a layer of black soil. Considerable difficulty was experienced in digging these samples on account of the exceedingly dry condition of ground. The plat from which these samples were taken had not been irrigated during the season, which accounts for the very dry condition of the soil. The soil from which samples 11 and 12 were taken was found to be very loose and friable, containing many pieces of soft sandstone at a depth of about 9 inches. A bed of loose sand was found at a depth of two feet, which appeared to be arranged in streaks throughout the soil, of a very fine texture and of a red color. As the depth increased, the soil became more moist. There were very few lumps found in this soil and they were very easily crushed by the fingers. On moistening these lumps with water, it was found that they absorbed moisture very quickly and became quite plastic. A few small pebbles were found, but constituted less than .1 per cent of the soil. These pebbles were of limestone, granite, lime incrustations on granite, quartz, sandstone, and shale.

*See Bulletin No. 14, page 114.

The following results were obtained from a mechanical analysis of these soils:

No. of Sample		Locality	Gravel (2–1 mm.)	Coarse sand (1–.5 mm.)	Medium sand (.5–.25 mm.)	Fine sand (.25–.1 mm.)	Very fine sand (.1–.05 mm.)	Silt (.05–.01 mm.)	Fine silt (.01–.005 mm.)	Clay (.005–.0001 mm.)	Moisture in air-dried sample	Organic and volatile matter	Loss
Top soil (0–12 in.)	Subsoil (12–24 in.)												
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
7		Sundance	0.005	0.045	0.070	0.640	64.005	10.735	1.885	14.000	2.020	4.180	2.415
	8	"	0.005	0.040	0.070	0.745	60.775	14.765	2.545	13.300	2.080	3.480	2.195
9		"	0.000	0.000	0.005	0.065	38.875	32.350	4.105	13.350	2.440	4.880	3.930
	10	"	0.000	0.000	0.015	0.365	38.500	30.995	7.465	15.150	2.040	4.960	0.510
11		"	0.565	0.375	1.670	3.975	54.925	12.420	4.730	14.400	1.280	4.980	0.680
	12	"	0.470	0.495	2.985	5.815	51.900	24.365	1.420	8.390	1.460	2.520	0.180
		Average	0.174	0.150	0.803	1.934	51.497	20.938	3.691	13.097	1.887	4.167	

The greatest yield of crops per acre upon this farm during three years is shown below.

Barley ....53 bush.
Bean ....9 bush.
Beet ....24,888 lbs.
Cabbage ....4,900 lbs.
Carrot ....14,014 lbs.
Corn ....50 bush.
Flax ....5.5 bush.
Garlic ....3,128 lbs.
Oat ....62 bush.
Onion ....32,640 lbs.
Parsnip ....2,728 lbs.
Pea ....23.3 bush.
Potato ....18,810 lbs.
Rye ....22.5 bush.
Salsify ....4,590 lbs.
Sugar beet ....13,167 lbs.
Timothy hay ....2,800 lbs.
Turnip ....16,744 lbs.
Wheat ....40 bush.

The following are the average yields per acre for three years upon the same farm:

Barley ....33.5 bush.
Bean ....5 bush.
Beet ....14,123 lbs.
Cabbage ....4,200 lbs.
Carrot ....7,336 lbs.
Corn ....39 bush.
Flax ....5 bush.
Oat ....29 bush.
Onion ....13,192 lbs.
Pea ....20 bush.
Potato ....6,730 lbs.
Rye ....11 bush.
Sugar beet ....7,774 lbs.
Turnip ....15,400 lbs.
Wheat ....27.5 bush.

We find that this farm stands first in producing the greatest yield of corn, and second in barley. It also ranks first in the average yield of these two crops.

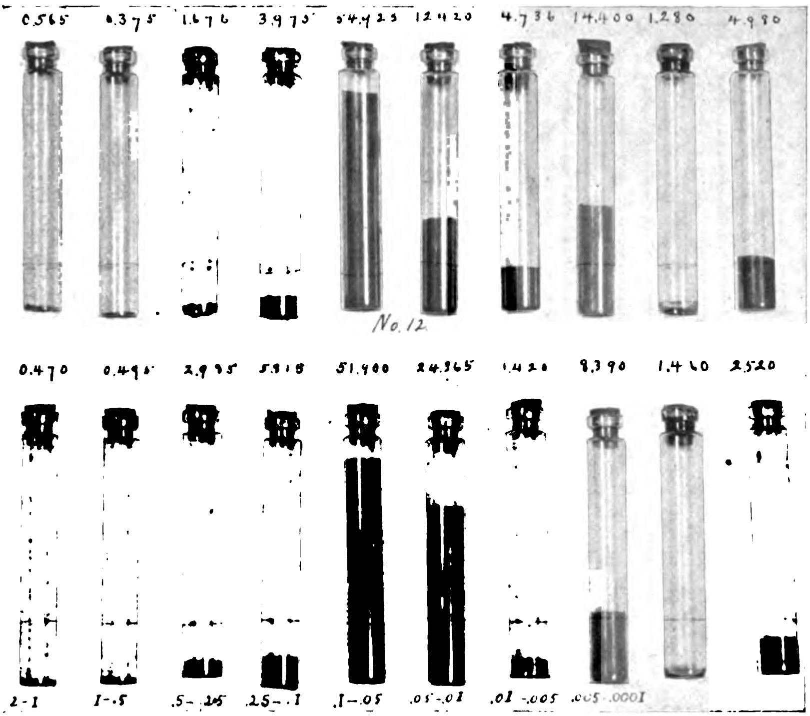
AGRICULTURAL SOILS OF WYOMING.

SUNDANCE EXPERIMENT FARM.

No. 11.

Per cent. of Gravel, Sand, Silt, Clay, Organic Matter and Water in 20 Grams of Soil and Subsoil.

Gravel	Coarse Sand	Medium Sand	Fine Sand	Very fine Sand	Silt	Fine Silt	Clay	Water	Organic Matter



mm. mm. mm. mm. mm. mm. mm. mm. mm. mm.

Diameter of Grains in Millimeter.

Soil from the Sheridan Experiment Farm.

The Sheridan farm is situated in the northern part of Wyoming, in the Tongue River valley, at an elevation of 3,750 feet. The underlying rock is of the Laramie group (Cretaceous), but the soil is alluvial, derived principally from Paleozoic and Mesozoic rocks.*

The native sod is blue stem (*Agropyron* sp.), porcupine grass (*Stipa comata* Trin.) and *Koeleria cristata* Pers. Around a stack of hay on the plat were found growing sweet clover (*Melilotus alba* Lam.), prairie clover (*Kuhnistera* sp.), sage-brush (*Artemisia tridentata* Nutt), gum plant (*Grindelia squarrosa* Dunal.), and lupine (*Lupinus* sp.)

In taking samples 13 and 14 the soil appeared to be about the same to the depth of three feet, becoming more moist, however, as the depth increased, and also a little darker in color. The top soil was dry but very friable. The soil of samples 15 and 16 was very dark, with the exception of five or six inches of the top soil, which was rather light in color. The ground was found to be moist and soft to a depth of at least two feet. This plat had been irrigated on July 17,and samples were taken August 15. The next top soil (sample 17) was soft, moist, and dark in color. At a depth of 19 inches occurred a streak of red soil which was very difficult to dig through. There were a few pebbles found scattered throughout the soil of this farm, consisting of granite, quartz, limestone, jasper, mica schist, oxide of iron concretions, and sandstone. The pebbles found constituted less than .1 per cent of the soil. The lumps found in the air-dry samples were so very hard that it was almost impossible to crush some of them with the rolling-pin. After being moistened with water, the hard lumps softened very quickly and the soil became plastic.

*See Bulletin No. 14, page 112.

The following results were obtained from a mechanical analysis of these samples:

No. of Sample: Top soil (0–12 in.)	No. of Sample: Subsoil (12–24 in.)	Locality	Gravel (2–1 mm.)	Coarse sand (1–.5 mm.)	Medium sand (.5–.25 mm.)	Fine sand (.25–.1 mm.)	Very fine sand (.1–.05 mm.)	Silt (.05–.01 mm.)	Fine silt (.01–.005 mm.)	Clay (.005–.0001 mm.)	Moisture in air-dried sample	Organic and volatile matter	Loss
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13		Sheridan	0.310	0.695	11.325	36.820	19.850	4.495	1.210	19.425	1.860	2.860	1.150
	14	"	0.355	0.745	13.960	37.910	17.195	3.480	1.175	18.495	2.440	2.540	1.705
15		"	0.105	0.585	10.395	36.160	18.170	5.590	1.950	19.705	2.720	3.660	0.960
	16	"	0.290	0.755	11.770	34.700	16.335	5.140	1.680	21.355	2.900	3.520	1.555
17		"	0.195	0.200	8.085	30.565	22.700	8.205	2.360	19.900	2.380	4.800	0.610
	18	"	0.100	0.420	7.860	29.875	19.930	7.505	3.075	22.865	3.060	4.400	0.910
		Average	0.226	0.567	10.566	34.339	19.030	5.735	1.905	20.289	2.560	3.630	

The greatest yield of crops per acre during three years upon this farm is shown below.

Alfalfa ....16,800 lbs.
Barley ....41.6 bush.
Bean ....21.6 bush.
Beet ....17,640 lbs.
Buckwheat ....26 bush.
Carrot ....97,440 lbs.
Corn ....40 bush.
Flax ....20.6 bush.
Lentil .... 9 bush.
Oat ....80 bush.
Onion ....20,294 lbs.
Pea ....15.1 bush.
Potato ....20,010 lbs.
Rye ....83 bush.
Sunflower ....30 bush.
Sugar beet ....40,400 lbs.
Timothy hay and clover ....7,200 lbs.
Turnip ....48,050 lbs.
Wheat ....54.5 bush.

The following are the average yields per acre upon the same farm for the same period of three years:

Alfalfa ....13,700 lbs.
Barley ....33 bush.
Bean ....11.5 bush.
Beet ....13,228 lbs.
Carrot ....56,100 lbs.
Corn ....24 bush.
Flax ....11 bush.
Oat ....49.1 bush.
Onion ....17,806 lbs.
Pea ....15.1 bush.
Potato ....12,145 lbs.
Rye ....17.6 bush.
Sugar beet ....24,022 lbs.
Turnip ....44,990 lbs.
Wheat ....31 bush.

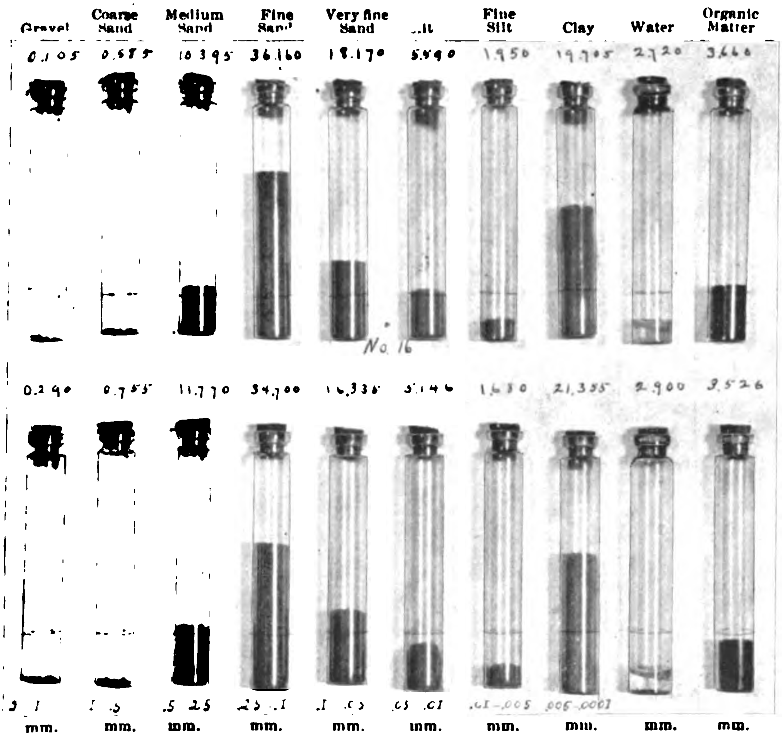
This farm was first in producing the greatest yield of alfalfa, carrots, flax, and rye, and second in raising turnips, beans, and wheat. In the average yield it stood first as a producer of carrots and oats.

AGRICULTURAL SOILS OF WYOMING.

SHERIDAN EXPERIMENT FARM.

No. 15.

Per cent. of Gravel, Sand, Silt, Clay, Organic Matter and Water in 20 Grams of Soil and Subsoil.



Diameter of Grains in Millimeter

Soil from the Lander Experiment Farm.

The Lander Experiment Farm is located in the central part of the state, in the Popo Agie River valley, at an altitude of 5,500 feet. The soil of one part of the farm is formed of decomposed red sandstone and clay, while another part is a mixture of decomposed marble and sandstone. The soil covers the Lower Triassic rocks, and most of the material entering into the composition of the soil came from the same formation.*

Samples 19 and 20 were taken from the prairie sod, upon which were growing blue stem (*Agropyron* sp.), coarse-leaved sage (*Artemisia* sp.), milk weed (*Asclepias* sp.), and rabbit-brush (*Chrysothamnus frigidus* Greene). The top soil was of a dark red color, moist to a depth of 10 inches below the surface, where it became dry, lighter in color and hard to dig. At a depth of 15 inches a streak of gravel three inches thick was found; beneath this gravel bed the soil appeared to be of red clay, quite soft and easy to dig. Samples 21, 22, 23, and 24 appeared to be of the same nature as 19 and 20, and occurring under similar conditions. The lumps found in the air-dried soil were very difficult to crush but absorbed water quickly and became quite friable.

The following results were obtained from a mechanical analysis of these samples:

*See Bulletin No. 14, page 108.

No. of Sample: Top soil (0-12 in.)	No. of Sample: Subsoil (12-21 in.)	Locality	Gravel (2-1 mm.)	Coarse sand (1-.5 mm.)	Medium sand (.5-.25 mm.)	Fine sand (.25-.1 mm.)	Very fine sand (.1-.05 mm.)	Silt (.05-.01 mm.)	Fine silt (.01-.005 mm.)	Clay (.005-.0001 mm.)	Moisture in air-dried sample	Organic and volatile matter	Loss
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19		Lander. .	0.245	0.180	0.725	4.270	64.245	9.620	1.715	12.635	1.860	3.180	1.325
	20	"	0.595	0.630	1.475	5.035	60.045	20.805	0.850	5.510	1.440	2.500	1.115
21		"	0.140	0.150	0.525	3.390	56.495	18.330	5.495	9.915	1.940	3.260	0.360
	22	"	0.125	0.165	1.055	4.795	58.070	17.100	5.295	8.895	1.320	2.720	0.460
23		"	0.080	0.085	0.090	1.725	47.885	15.060	6.765	21.625	2.440	3.560	0.665
	24	"	0.130	0.080	0.160	1.475	41.930	19.065	8.685	21.625	1.800	4.020	1.030
		Average	0.219	0.215	0.671	3.448	54.745	16.663	4.434	13.367	1.800	3.207	

The greatest yield of crops per acre during three years upon this farm is shown below.

Alfalfa ....8,000 lbs.
Barley ....12 bush.
Bean ....16 bush.
Beet ....62,627 lbs.
Cabbage ....62,954 lbs.
Cauliflower ....11,904 lbs.
Carrot ....40,671 lbs.
Corn ....23.4 bush.
Flax ....16.1 bush.
Lentil ....2,730 lbs.
Lettuce ....5,672 lbs.
Oat ....60 bush.
Onion ....20,869.3 lbs.
Pea ....45.5 bush.
Potato ....40,933 lbs.
Radish ....3,373 lbs.
Rye ....44.5 bush.
Sugar beet ....62,627 lbs.
Turnip ....38,928 lbs.
Wheat ....35 bush.

The following are the average yields per acre upon the same farm for the same period:

Alfalfa ....3,500 lbs.
Barley ....10.5 bush.
Bean ....12.6 bush.
Beet ....30,644.6 lbs.
Cabbage ....59,157.9 lbs.
Carrot ....28,772 lbs.
Corn ....19.75 bush.
Flax ....16.1 bush.
Oat ....33 bush.
Onion ....14,529.7 lbs.
Pea ....33.3 bush.
Potato ....16,303 lbs.
Rye ....19.6 bush.
Sugar beet ....44,357 lbs.
Turnip ....34,715 lbs.
Wheat ....20 bush.

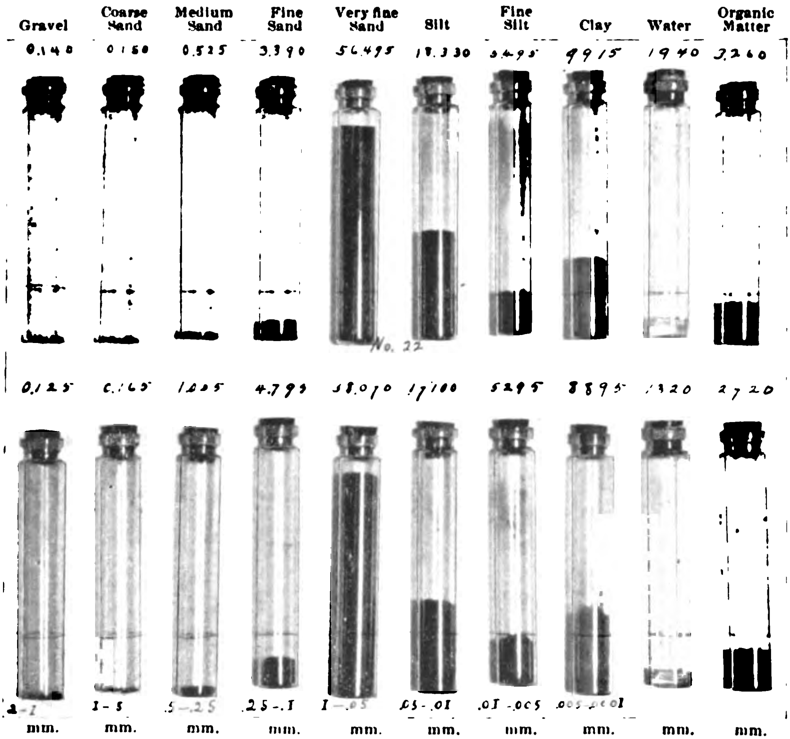
This farm produced the greatest yield of beets, cabbage, peas, potatoes, and sugar beets, and was second in raising the most onions and rye. In the average yield it stood first as a producer of beets, cabbage, peas, potatoes, rye, and sugar beets.

AGRICULTURAL SOILS OF WYOMING.

LANDER EXPERIMENT FARM.

No. 21.

Per cent. of Gravel, Sand, Silt, Clay, Organic Matter and Water in 20 Grams of Soil and Subsoil.



Diameter of Grains in Millimeter.

Soil from the Laramie Experiment Farm.

The Experiment Farm is situated in the southeastern part of the state at an altitude of 7,200 feet. The soil covers the Cretaceous sandstone and is composed of Archaean, Mesozoic,and Paleozoic rocks.* Well-worn pebbles of schist, gneiss, quartz, orthoclase, and granite were found which composed about 11 per cent of the soil.

Samples 25 and 26 were taken from the prairie sod, which was very dry and quite difficult to dig the first foot. As the depth increased the soil became more moist and much less difficult to dig till the depth of two feet was reached, when a hard pan was struck which was about two inches thick and quite difficult to penetrate with the spade. Samples 27 and 28 were taken from soil which had been cultivated, and which was found to be quite moist at the time of digging the samples. Samples 29 and 30 were taken from a plat which had been abandoned on account of the great quantity of alkali contained in the soil. The earth was found to be very moist to a depth of three feet. The lumps found in the air-dried samples 25 and 26 were very hard to crush, but those from 27, 28, 29, and 30 crumbled very readily. The lumps absorbed moisture quickly and became quite plastic. The soil was of a light gray color and became very light at the depth of three feet.

The mechanical analysis gave the following results:

*See Bulletin No. 14, page 105.

No. of Sample: Top soil (0-12 in.)	No. of Sample: Subsoil (12-24 in.)	Locality	Gravel (2-1 mm.)	Coarse sand (1-.5 mm.)	Medium sand (.5-.25 mm.)	Fine sand (.25-.1 mm.)	Very fine sand (.1-.05 mm.)	Silt (.05-.01 mm.)	Fine silt (.01-.005 mm.)	Clay (.005-.0001 mm.)	Moisture in air-dried sample	Organic and volatile matter	Loss
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
25		Laramie .	3.390	3.030	7.405	16.295	32.075	8.390	3.440	19.285	3.260	3.060	0.370
	26	"	8.950	4.045	6.890	11.780	21.175	5.770	2.870	30.530	2.360	2.600	3.030
27		"	5.570	5.070	10.060	19.880	34.915	2.900	1.585	14.040	1.640	2.180	2.160
	28	"	5.655	3.640	7.200	15.575	24.725	4.750	4.205	28.300	2.740	2.440	0.770
29		"	8.280	4.335	8.515	16.785	33.450	5.065	1.505	16.750	1.920	2.900	0.495
	30	"	2.890	2.650	6.560	15.140	27.715	5.490	3.915	29.005	2.940	3.040	0.655
		Average	5.789	3.795	7.772	5.909	29.009	5.394	2.920	22.985	2.477	2.703	

The greatest yield of crops per acre during three years upon this farm is shown below.

Alfalfa ....6,030.4 lbs.
Barley ....94.1 bush.
Beet ....27,514 lbs.
Cabbage ....16,151 lbs.
Cauliflower ....2,588 lbs.
Carrot ....21,107 lbs.
Flat pea ....3,416 lbs.
Flax ....18.4 bush.
Garlic ....4,309 lbs.
Kahlrabi ....15,475 lbs.
Leek ....28,189 lbs.
Lettuce ....60,984 lbs.
Oat ....109.5 bush.
Onion ....48,094 lbs.
Parsley ....21,251 lbs.
Pea ....24.9 bush.
Potato ....32,988 lbs.
Rape ....29,180 lbs.
Radish ....36,028 lbs.
Rye ....34.3 bush.
Spinach ....46,827 lbs.
Sugar beet ....56,784 lbs.
Turnip ....68,244 lbs.
Wheat ....78.7 bush.

The following are the average yields per acre upon the same farm for the same period:

Alfalfa ....3,106 lbs.
Barley ....33.1 bush.
Beet ....16,413 lbs.
Cabbage ....3,973 lbs.
Carrot ....13,583 lbs.
Flax ....15.6 bush.
Oat ....42.8 bush.
Onion ....37,930 lbs.
Pea ....17.5 bush.
Potato ....11,713 lbs.
Rye ....14.2 bush.
Sugar beet ....18,149.8 lbs.
Turnip ....20,173.8 lbs.
Wheat ....29.3 bush.

This farm excelled all the others in producing the greatest amount of barley, turnips, and wheat, and was second in the production of flax, peas, potatoes, and sugar beets. In the average yield, it stood first in raising flax.

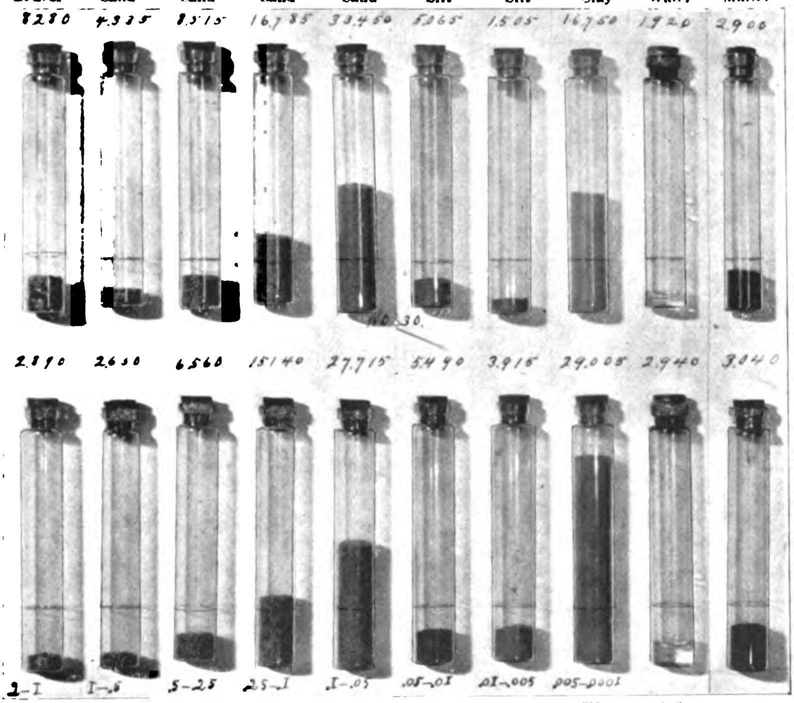
AGRICULTURAL SOILS OF WYOMING.

LARAMIE EXPERIMENT FARM.

No. 29.

Per cent. of Gravel, Sand, Silt, Clay, Organic Matter and Water in 20 Grams of Soil and Subsoil.

Gravel	Coarse Sand	Medium Sand	Fine Sand	Very fine Sand	Silt	Fine Silt	Clay	Water	Organic Matter



mm. mm. mm. mm. mm. mm. mm. mm. mm. mm.

Diameter of Grains in Millimeter.

Greatest Yield per Acre on Each of the Five Experiment Farms During Three Years.

Crop.	Wheatland	Sundance.	Sheridan	Lander	Laramie
Alfalfa	8,732 lbs.	. . . .	16,800 lbs.	8,000 lbs.	6,030.4 lbs.
Barley	50 bush.	53 bush.	41.6 bush.	12 bush.	94.1 bush.
Bean	26 bush.	9 bush.	21.6 bush.	16 bush.	. . . .
Beet	43,776 lbs.	24,888 lbs.	17,640 lbs.	62,627 lbs.	27;514.7 lbs.
Cabbage	34,362 lbs.	4,900 lbs.	. . . .	62,954.2 lbs.	16,151.1 lbs.
Carrot	75,240 lbs.	14,014 lbs.	97,440 lbs.	40,671.3 lbs.	21,107.2 lbs.
Corn	48 bush.	50 bush.	40 bush.	23.4 bush.	. . . .
Flax	14 bush.	5.5 bush.	20.6 bush.	16.1 bush.	18.4 bush.
Oat	74.2 bush.	62 bush	80 bush.	60 bush.	109.5 bush.
Onion	93,492 lbs.	32,640 lbs.	20,294 lbs.	20,869.3 lbs.	48,094 lbs.
Pea	17 bush.	23.3 bush.	15.1 bush.	45.5 bush.	24.9 bush.
Potato	25,740 lbs.	18,810 lbs.	20,010 lbs.	40,932 lbs.	32,988 lbs.
Rye	31 bush.	22.5 bush.	83 bush.	44.5 bush.	34.3 bush.
Sugar Beet	24,000 lbs.	13,167 lbs.	40,400 lbs.	62,627.5 lbs.	56,784 lbs.
Turnip	12,869 lbs.	16,744 lbs.	48,050 lbs.	38,928.3 lbs.	68,244.6 lbs.
Wheat	50 bush.	40 bush.	54.5 bush.	35 bush.	78.7 bush.

Greatest Average Yield per Acre on Each of the Five Experiment Farms During Three Years.

Crop.	Wheatland	Sundance	Sheridan	Lander	Laramie
Alfalfa	5,113 lbs.	. . . .	13,700 lbs	3,500 lbs.	3,106.4 lbs.
Barley	27.5 bush.	33.5 bush.	33 bush.	10.5 bush.	33.1 bush.
Bean	22 bush.	5 bush.	11.5 bush.	12.6 bush.	. . . .
Beet	20,800 lbs.	14,123 lbs.	13,228 lbs.	30.646.6 lbs.	16,413.6 lbs.
Cabbage	27,333 lbs.	4,200 lbs.	. . . .	59,157 lbs.	3,973.6 lbs.
Carrot	42,816 lbs.	7,336 lbs.	56,100 lbs.	28,772 lbs.	13,583 lbs.
Corn	23 bush.	39 bush.	24 bush.	19.75 bush.	. . . .
Flax	9 bush.	5 bush.	11 bush	16.1 bush.	15.6 bush.
Oat	39.6 bush.	29 bush.	49.1 bush.	33 bush.	42.8 bush.
Onion	60,746 lbs.	13,192 lbs.	17,806 lbs.	14,529.7 lbs.	37,930 lbs.
Pea	16.5 bush.	20 bush.	15.1 bush.	33.3 bush.	17.5 bush.
Potato	6,860 lbs.	6,730 lbs.	12,145 lbs.	16,303 lbs.	11,713 lbs.
Rye	19 bush.	11 bush.	17.6 bush.	19.6 bush.	14.2 bush.
Sugar Beet	16,330 lbs.	7,774 lbs.	24,022 lbs.	44,357 lbs.	18,149.8 lbs.
Turnip	10,725 lbs.	15,400 lbs.	44,990 lbs.	34,715 lbs.	20,173.8 lbs.
Wheat	26.3 bush.	27.5 bush.	31 bush.	20 bush.	29.3 bush.

Chemical Analysis of Wyoming Soils.

The soils of the Wyoming Experiment Farms were analyzed by E. E. Slosson, Chemist of the Station, in 1892, before they had been cultivated, and the analyses were published in Bulletin No. 6. As that bulletin is out of print, averages of the analyses of the surface and subsoil of each farm are here republished.

WHEATLAND EXPERIMENT FARM.

Analysis of fine earth.	Surface 1-9 in.	Subsoil 9-18 in.
Insoluble matter	77.92	72.18
Soluble silica	3.52	1.36
Potash (K_2O)	.63	.41
Soda (Na_2O)	.34	.34
Lime (CaO)	.87	5.29
Magnesia (MgO)	.85	1.29
Iron (Fe_2O_3)	3.52	2.94
Alumina (Al_2O_3)	6.88	5.09
Phosphoric acid (P_2O_5)	.14	.15
Sulphuric acid (SO_3)	.08	.08
Carbcnic acid (CO_2)	.88	5.39
Moisture	1.62	1.80
Volatile and combustible matter	3.62	3.04
	100.87	99.36
Soluble in water	.1726	.0427
Chlorine	.007	.0007

SUNDANCE EXPERIMENT FARM.

Analysis of fine earth.	Surface 1-9 in.	Subsoil 9-18 in.
Insoluble matter	68.39	75.27
Soluble silica	.98	1.87
Potash (K_2O)	.68	.53
Soda (Na_2O)	.90	.30
Lime (CaO)	4.97	2.30
Magnesia (MgO)	3.21	2.12
Iron (Fe_2O_3)	3.40	3.17
Alumina (Al_2O_3)	5.42	5.86
Phosphoric acid (P_2O_5)	.18	.19
Sulphuric Acid (SO_3)	.18	.18
Carbonic acid (CO_2)	6.53	1.68
Moisture	1.88	1.88
Volatile and combustible matter	3.60	4.36
	100.32	99.71
Soluble in water	.0505	.0777
Chlorine	.0003	.0014

SHERIDAN EXPERIMENT FARM.

Analysis of fine earth.	Surface 1-9 in.	Subsoil 9-18 in.
Insoluble matter	81.72	71.74
Soluble silica	1.57	1.59
Potash (K_2O)	.52	.59
Soda (Na_2O)	.20	.34
Lime (CaO)	.69	1.19
Magnesia (MgO)	.94	2.26
Iron (Fe_2O_3)	2.98	4.09
Alumina (Al_2O_3)	5.83	8.75
Phosphoric acid (P_2O_5)	.28	.23
Sulphuric acid (SO_3)	.14	.24
Carbonic acid (CO_2)		.59
Moisture	1.73	3.23
Volatile and combustible matter	3.81	4.92
	100.41	99.76
Soluble in water	.0498	.2701
Chlorine	.0008	.0014

LANDER EXPERIMENT FARM.

Analysis of fine earth.	Surface 1-9 in.	Subsoil 9-18 in.
Insoluble matter	74.66	70.31
Soluble silica	2.08	2.43
Potash (K_2O)	.64	.67
Soda (Na_2O)	.24	.35
Lime (CaO)	3.64	6.46
Magnesia (MgO)	1.51	1.62
Iron (Fe_2O_3)	2.48	3.05
Alumina (Al_2O_3)	3 69	4 60
Phosphoric acid (P_2O_5)	.17	.18
Sulphuric acid (CO_3)	.10	.08
Carbonic acid (CO_2)	2.39	4.29
Moisture	1.78	1.57
Volatile and combustible matter	6.22	3.92
	99.60	99.53
Soluble in water	.2599	.1110
Chlorine	.0505	.0038

LARAMIE EXPERIMENT FARM.

Analysis of fine earth.	Surface 1-9 in.	Subsoil 9-18 in.
Insoluble matter	80.11	77.28
Soluble silica	2.78	1.92
Potash (K_2O)	.60	.53
Soda (Na_2O)	.65	.45
Lime (CaO)	1.14	3.77
Magnesia (MgO)	.45	.08
Iron (Fe_2O_3)	2.79	2.49
Alumina (Al_2O_3)	4.95	4.71
Phosphoric acid (P_2O_5)	.14	.15
Sulphuric acid (SO_3)		.07
Carbonic acid (CO_2)	.69	3.70
Moisture	1.87	1.24
Volatile and combustible matter	3.21	2.82
	99.38	99.21
Soluble in water	.0829	.0464
Chlorine	.001	.001

Professor Hilgard, of the University of California, has this to say in regard to the amount of lime, phosphoric acid, and potash necessary to give a soil lasting fertility:

"The *lime* percentage should not fall below 0.1 per cent in thelightest sandy soils; in clay loams not below 0.25 per cent, and in heavy clay soils not below 0.5 per cent; and it may advantageously rise to 1 and even 2 per cent as a maximum. Beyond the latter figure it seems in no case to act more favorably than a less amount, unless it be mechanically.

"The percentage of *phosphoric acid* is that which, in connection with the lime, seems to govern most commonly the productiveness of our virgin soils. In any of these, less than .05 must be regarded as a serious deficiency, unless accompanied by a large amount of lime. In sandy loams, 0.1 per cent, when accompanied by a fair supply of lime, secures fair productiveness for from eight to fifteen years; with a deficiency of lime, twice that percentage would only serve for a similar time.

"The *potash* percentages of soils seem, in a large number of cases, to vary with that of 'clay;' that is, in clay soils they are usually high, in sandy soils low; and since subsoils are in all ordinary cases more clayey than surface soils, their potash percentages are almost invariably higher.

"The potash percentage of heavy clay upland soil, and clay loams, ranges from about 0.8 to 0.5 per cent; lighter loams from 0.45 to 0. 30 per cent; sandy loams below 0.3 per cent, and sandy soils of great depth may fall below 0.1 per cent consistently with good productiveness and durability. Virgin soils falling below 0.6 per cent in potash seem in most cases to be deficient in available potash, its application to such soils being followed by an immediate great increase of production. Sometimes, however, a soil very rich in lime and phosphoric acid, shows good productiveness, despite a

very low potash percentage, and conversely, a high potash percentage seems capable of offsetting a low one of lime."

From the chemical analyses of the soils of the five Experiment Farms, as shown by the preceding tables, we find these soils to contain the following percentages of lime, phosphoric acid, and potash:

		Lime.	Phosphoric acid	Potash
Wheatland	Soil	.87	.14	.63
	Subsoil	5.29	.15	.41
Sundance	Soil	4.97	.18	.68
	Subsoil	2.30	.19	.53
Sheridan	Soil	.69	.28	.52
	Subsoil	1.19	.23	.59
Lander	Soil	3.64	.17	.64
	Subsoil	6.46	.18	.67
Laramie	Soil	1.14	.14	.60
	Subsoil	3.77	.15	.53

From this we conclude that the soils of Wyoming will last at least for some years with continual tillage, and without the necessity of resorting to artificial fertilizers.

In Bulletin No. 5, U. S. Department of Agriculture, Division of Agricultural Soils, are to be found the results of the mechanical analysis of some typical truck, wheat, and grass lands. The typical truck land was found at Marley, Md., the typical wheat land at Davidsonville, Md., and the typical grass land at Hagerstown, Md.

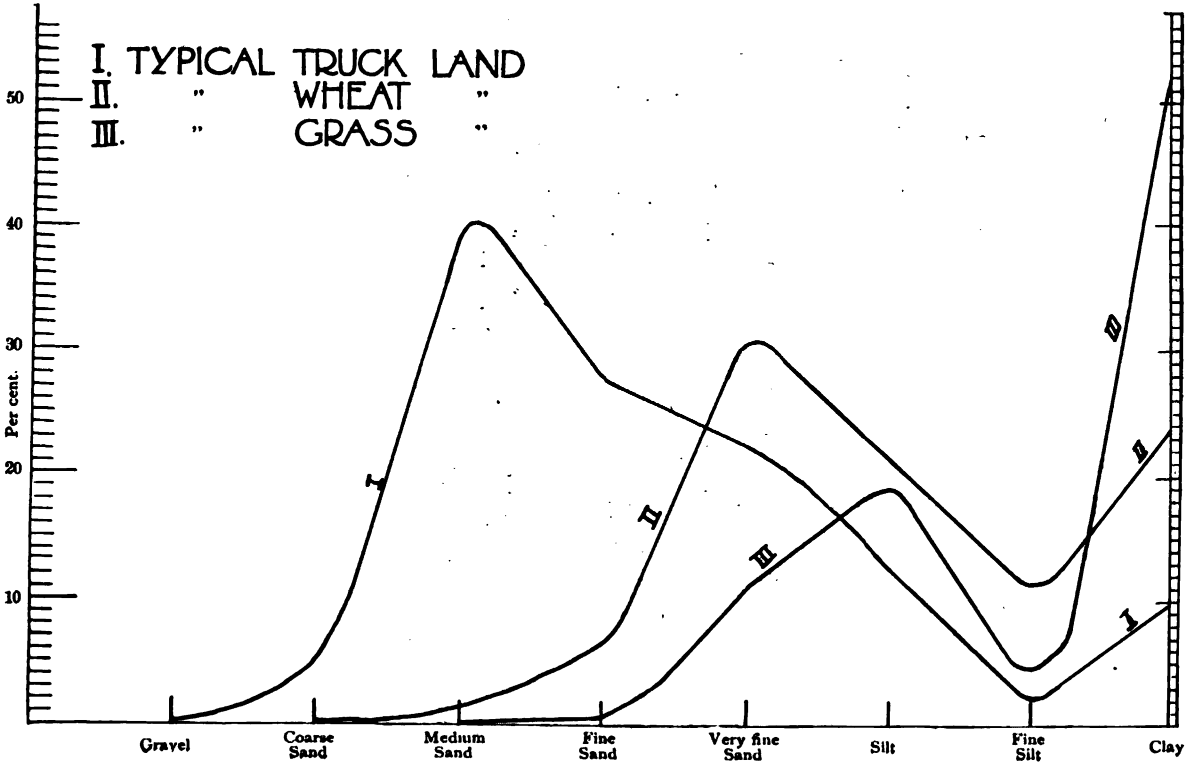
The following table shows the per cent of grains of various texture entering into the composition of these soils, and immediately following, for the sake of comparison, is a similar table of the soils of Wyoming.

	Truck.	Wheat.	Grass.
Gravel	0.49	0.00	0.00
Coarse sand	4.96	0.23	0.08
Medinm sand	40.19	1.71	[illegible]
Fine sand	27.59	6.08	0.53
Very fine sand	12.1	30.82	10.94
Silt	7.74	20.92	19.02
Fine silt	2 23	11.21	4.67
Clay	4.4	23.78	51.75

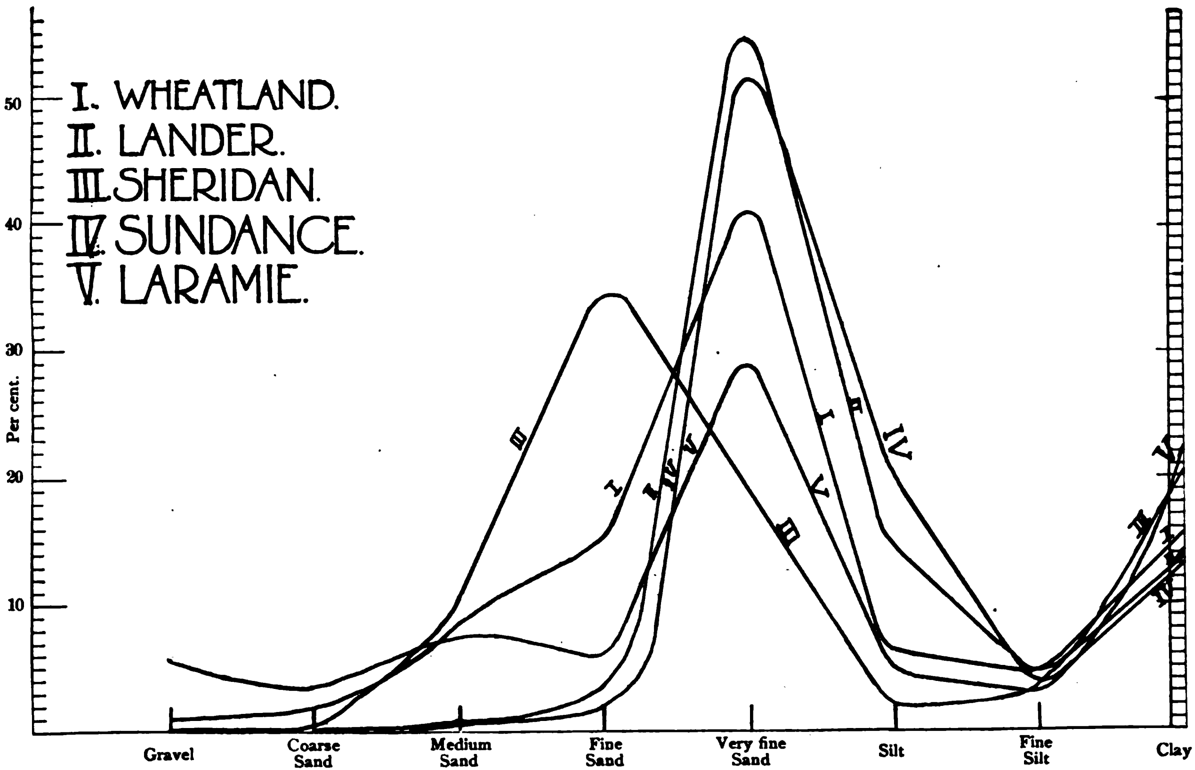
	Wheatland	Sundance	Sheridan	Lander	Laramie
Gravel	1.05	0.17	0.22	0.21	5.78
Coarse sand	1.85	0.15	0.56	0.21	3.79
Medium sand	8.60	0.80	10.56	0.67	7.77
Fine sand	15.09	1.93	34.33	3.44	5.90
Very fine sand	40.16	51.49	19.03	54.74	29.00
Silt	6.18	20.93	5.73	16.66	5.39
Fine silt	4.33	3.69	1.90	4.43	2.92
Clay	15.19	13.09	20.28	13.36	22.98

From these tables, and especially from the charts which immediately follow, one can readily see that none of the soils of Wyoming resemble the typical soils of the Atlantic Coast States very closely.

On the charts, the curves, which might be termed "soil-texture curves," have for abscissas the different sized grains, and for ordinates the per cent of the different sized grains composing the soil. The soils from Lander and Sundance are very similar, while those from Laramie, Wheatland, Lander, and Sundance resemble one another in that they all contain more very fine sand than of any other quality. The soils from these four farms resemble the typical wheat land of the east more than they resemble either the truck or grass land. The soil of the Sheridan farm is more like the typical truck land; and yet this farm produced a better crop of alfalfa than any of the other four.



SOIL-TEXTURE CURVES.



SOIL-TEXTURE CURVES.

DETERMINATION OF MOISTURE

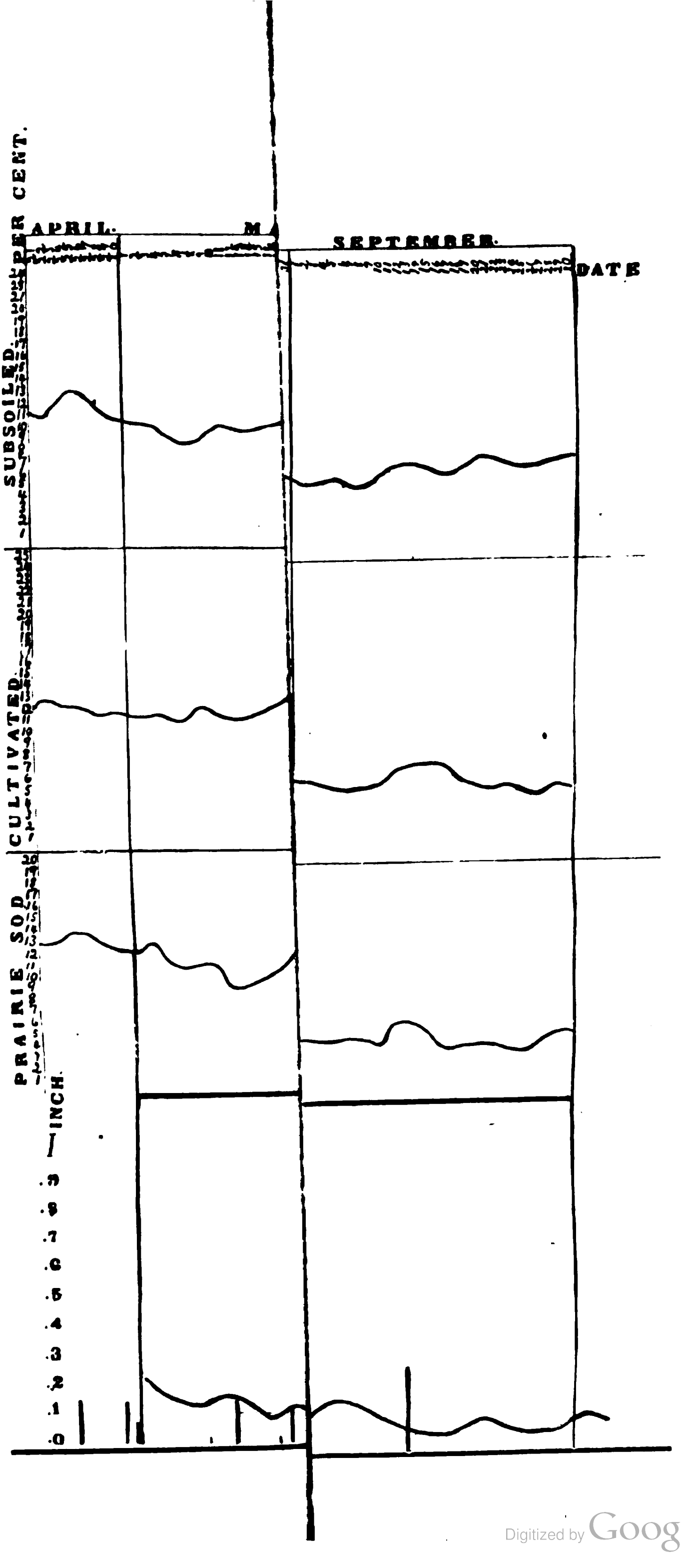
. . . IN THE . . .

Soil of the Laramie Experiment Farm

FOR THE YEAR 1897.

The work of taking samples of soil was begun on April 20, 1897, and continued without intermission till the first of September of the same year. The samples were taken with brass tubes about ⅞ inch in internal diameter and 16 inches long. In one end of the tube a brass collar had been securely fastened, and this end then turned down on a lathe till it tapered in as far as the collar. The object of the collar was to cut a core of earth as the tube was driven into the soil with a wooden mallet to the depth of 12 inches. The tube with its contents was carefully withdrawn from the earth and each end closed with a rubber stopper to prevent any evaporation of moisture. The samples, which were taken each day at 5:30 p. m., were carefully weighed in aluminum dishes, placed in a drying oven for 24 hours and kept at a constant temperature of 93°C., (the temperature at which water boils in this altitude).

Three plats, each 25 feet square, were chosen from which to take soil. Stakes were driven at the corners of the plats and ropes stretched around to prevent trespassing. Plat No. 1 was on the prairie sod, upon which were growing buffalo grass (*Bulbilis dactyloides*) and blue stem (*Agropyron* sp.) Plat No. 2 was on ground which had been plowed and harrowed but not subsoiled. In Plat No. 3 the soil had been plowed, subsoiled, and harrowed. Both Plats Nos. 2 and 3 were planted to Surprise oats on May 4th, irrigated June 27 and July 26, and harvested August 16. The results were as follows: Length of straw from both plats, 3.2 feet; length of stubble, .2 feet; yield of straw on Plat No. 2, 2,184


PER CENT.
APRIL.
SEPTEMBER.
DATE
SUBSOILED.
CULTIVATED.
PRAIRIE SOD
INCH
.9
.8
.7
.6
.5
.4
.3
.2
.1
.0

lbs. per acre; on Plat No. 3, 2.209 lbs.; yield of grain on Plat No. 2, 1,193.7 lbs.; on Plat No. 3, 2,209.6 lbs.

The etching which accompanies this article, is, doubtless, self-explanatory. It may, however, be well to state that the heavy dark lines extending from the bottom of the page towards the top represent the amount of rainfall in inches, as indicated by the scale at the left.

In the tables which follow I have calculated the per cent of moisture in terms of the total weight of the soil as it came from the field. I found that the amount of moisture in samples of the same soil taken the same day, and not more than 12 inches apart, varied from 2 to 4 per cent. In the tables the original figures are printed and not data from the graphical representations.

The first thing to be observed on the chart, perhaps, will be the fact that the highest part of the curve is reached two or three days after a heavy fall of rain, which is doubtless caused by seepage of water from a higher level, as the farm slopes toward the east about two feet in every hundred. On the prairie sod, Plat No. 1, the general trend of the curve was down to about 5 per cent, which point it reached at the end of June. From this on till the end of the season the curve fluctuated between 5 and 9 per cent.

Just before the first irrigation the moisture content of the soil from Plat No. 1 was about 8 per cent, from Plat No. 2 6½ per cent, and from Plat No. 3 7 per cent. Before the second irrigation the moisture content in Plat No. 1 was 7 per cent, in Plat No. 2 8 per cent, and Plat No. 3 7 per cent. At the end ofthe season we find that in the prairie sod the moisture content was 6 per cent, while in the cultivated it was 6½ per cent, and in the subsoiled land 8½ per cent. After the first irrigation the moisture content fell during four days 8 per cent in the cultivated and 7½ per cent in the subsoiled ground; while after the second irrigation it fell the first four days only 3 per cent in the cultivated and 4 per cent in the subsoiled.

Moisture Content of Soil, Laramie Experiment Farm, Laramie, Wyoming, 1897.

PLAT NO. 1—PRAIRIE SOD.

Day	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER		
	Moisture	Rain	Evaporation	Moisture	Rain	Evaporation	Moisture	Rain	Evaporation	Moisture	Rain	Evaporation	Moisture	Rain	Evaporation	Moisture	Rain	Evaporation
	Per c'nt	Inch's	Inch's	Per c'nt	Inch's	Inch's	Per c'nt	Inch's	Inch's	Per c'nt	Inch's	Inch's	Per c'nt	Inch's	Inch's	Per c'nt	Inch's	Inch's
1	...	...	...	12.76	...	0.14	11.97	0.02	0.13	3.11	...	0.12	6.24	0.04	0.12	6.41	...	0.12
2	...	...	...	13.02	...	0.12	12.68	0.06	0.08	5.27	...	0.18	7.90	0.09	0.07	5.38	...	0.22
3	...	...	...	12.34	...	0.11	11.07	0.12	0.12	7.59	...	0.19	9.67	0.42	0.10	5.58	...	0.12
4	...	...	...	10.26	...	0.22	10.55	0.01	0.09	6.46	0.19	0.12	9.29	0.21	0.09	5.50	...	0.06
5	...	...	...	...	...	0.09	10.90	0.02	0.00	7.44	...	0.18	9.26	0.12	0.18	6.50	...	0.18
6	...	...	...	11.74	...	9.23	9.58	...	0.08	7.40	...	0.24	7.65	0.05	0.07	5.22	...	0.10
7	...	...	...	10.19	0.01	0.09	9.53	...	0.10	7.93	...	0.22	8.86	...	0.20	6.08	...	0.14
8	...	...	...	12.06	...	0.20	10.00	0.05	0.17	7.51	...	0.12	8.67	0.14	0.06	4.66	...	0.10
9	...	...	...	8.59	...	0.17	11.72	0.14	0.10	6.33	0.20	0.10	8.95	...	0.04	5.55	...	0.10
10	...	...	...	11.22	0.15	0.08	12.00	0.25	0.19	6.68	0.36	0.08	8.01	0.02	0.08	4.42	...	0.04
11	...	...	...	8.50	...	0.05	14.17	...	0.10	8.65	...	0.42	8.46	...	0.08	8.01	0.31	0.13
12	...	...	...	8.96	...	0.06	14.86		0.10	7.35	...	0.04	6.43	...	0.18	6.84	0.01	0.09
13	...		...	9.53	...	0.20	...	...	0.10	6.64	...	0.26	5.56	...	0.12	7.82	...	0.06
14	...	...	...	10.68	...	0.14	11.79	...	0.10	9.30	0.10	0.04	6.42	...	0.26	6.74	...	0.06
15	...	...	...	9.15	0.02	0.08	9.26	...	0.30	6.07	...	0.14	5.60	...	0.16	7.83	...	0.12
16	...	...	...	...	0.12	0.02	7.94	...	0.32	8.23	0.01	0.16	7.57	...	0.14	5.96	...	0.14
17	...	...	...	7.63	...	0.14	11.05	...	0.16	5.85	...	0.12	5.39	...	0.14	5.10	...	0.16
18	...	...	...	13.25	0.20	0.12	8.97	...	0.20	7.18	0.10	0.22	6.35	...	0.16	4.45	...	0.12
19	...	...	...	11.81	...	0.16	7.88	...	0.24	7.07	...	0.08	3.86	...	0.20	5.52	...	0.08
20	13.05	...	...	15.52	1.01	0.08	10.57	...	0.18	7.71	...	0.14	5.28	...	0.06	5.24	...	0.08
21	13.03	...	...	15.50	0.12	0.08	7.63	0.05	0.07	8.68	...	0.06	4.76	...	0.14	5.28	...	0.08
22	13.29	...	...	14.20	0.13	0.04	9.78	...	0.12	7.57	...	0.37	6.91	...	0.14	5.41	...	0.08
23	14.28	0.15	...	14.20	...	0.14	7.58	...	0.16	8.23	0.08	0.06	6.63	...	0.12	5.06	...	0.08
24	14.02	...	...	13.84	...	0.12	...	...	0.24	7.41	0.21	0.13	5.44	...	0.16	2.52	...	0.06
25	13.92	...	0.42	13.55	...	0.10	...	...	0.18	8.16	...	0.12	6.03	...	0.28	4.97	...	0.14
26	13.42	...	0.42	13.61	...	0.19	7.69	...	0.30	5.12	...	0.12	5.65	0.01	0.07	3.81	...	0.10
27	8.40	...	0.34	...	...	0.11	7.15	...	0.22	5.91	...	0.16	4.77	0.01	0.05	4.25	...	0.12
28	12.32	0.14	0.22	12.98	...	0.13	6.09	...	0.08	7.30	...	0.22	5.86	...	0.12	6.53	...	0.16
29	13.52	0.07	0.02	12.40	...	0.10	6.12	...	0.24	6.22	...	0.08	4.91	...	0.16	5.60	...	0.08
30	12.03	...	0.16	12.05	0.08	0.13	6.27	...	0.16	5.20	...	0.12	5.31	...	0.10	6.33	...	0.12
31	...	...	...	13.35	...	0.08	...	...	...	6.75	0.09	0.23	5.77	...	0.20	...	...	...

Moisture Content of Soil, Laramie Experiment Farm, Laramie, Wyoming, 1897.

PLAT NO. 2—CULTIVATED.

Day	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER		
	Moist-ure	Rain	Evap-ora-tion	Moist-ure	Rain	Evap-ora-tion	Moist-ure	Rain	Evap-ora-tion	Moist-ure	Rain	Evap-ora-tion	Moist-ure	Rain	Evap-ora-tion	Moist-ure	Rain	Evap-ora-tion
	Per c'nt	*Inch's*	*Inch's*	*Per c'nt*	*Inch's*	*Inch's*	*Per c'nt*	*Inch's*	*Inch's*	*Per c'nt*	*Inch's*	*Inch's*	*Per c'nt*	*Inch's*	*Inch's*	*Per c'nt*	*Inch's*	*Inch's*
1	...	...	...	11.57	...	0.14	10.88	0.02	0.13	13.67	...	0.12	11.60	0.04	0.12	7.53	...	0.12
2	...	...	...	11.55	...	0.12	10.93	0.06	0.08	14.27	...	0.18	13.70	0.09	0.07	7.07	...	0.22
3	...	...	...	11.84	...	0.11	11.83	0.12	0.12	14.23	0.19	0.19	15.25	0.42	0.10	6.14	...	0.12
4	...	...	...	11.47	...	0.22	13.03	0.01	0.09	11.42	...	0.12	14.50	0.21	0.09	7.68	...	0.06
5	...	...	...	...	...	0.09	8.99	0.02	0.00	13.22	...	0.16	14.60	0.12	0.18	7.03	...	0.18
6	...	...	...	10.95	...	0.23	11.01	...	0.08	11.51	...	0.24	12.86	0.05	0.07	7.14	...	0.10
7	...	...	...	11.89	0.01	0.09	11.28	...	0.10	11.12	...	0.22	14.98	...	0.20	8.55	...	0.14
8	...	...	...	14.95	...	0.20	10.91	0.05	0.17	9.58	...	0.12	12.88	0.14	0.06	7.19	...	0.10
9	...	...	...	11.85	...	0.17	12.90	0.14	0.10	9.77	0.20	0.10	12.96	...	0.04	8.55	...	0.10
10	...	...	...	10.27	0.15	0.08	16.50	0.25	0.19	10.78	0.36	0.08	12.49	0.02	0.08	7.27	...	0.04
11	...	...	...	12.76	...	0.05	14.76	...	0.10	11.50	...	0.42	13.06	...	0.08	12.15	0.31	0.13
12	...	...	...	12.19	...	0.06	12.74	...	0.10	8.37	...	0.04	11.64	...	0.18	9.46	0.01	0.09
13	...	...	...	10.30	...	0.20	...	...	0.10	7.52	...	0.26	9.40	...	0.12	8.35	...	0.06
14	...	...	...	12.49	...	0.14	11.21	...	0.10	9.71	0.10	0.04	9.93	...	0.26	9.11	...	0.06
15	...	...	...	13.36	0.02	0.08	9.05	...	0.30	8.40	...	0.14	10.08	...	0.16	9.92	...	0.12
16	...	...	...	...	0.12	0.02	7.03	...	0.32	9.40	0.01	0.16	9.18	...	0.14	9.47	...	0.14
17	...	...	...	11.35	...	0.14	11.14	...	0.16	7.42	...	0.12	8.80	...	0.14	7.76	...	0.16
18	...	...	...	14.00	0.20	0.12	9.26	...	0.20	8.22	0.10	0.22	10.08	...	0.16	9.04	...	0.12
19	...	...	...	12.97	...	0.16	8.87	...	0.24	8.03	...	0.08	10.68	...	0.20	4.28	...	0.08
20	12.56	...	...	16.91	1.01	0.08	8.52	...	0.18	8.48	...	0.14	8.96	...	0.06	8.18	...	0.08
21	13.46	...	...	14.34	0.12	0.08	8.23	0.05	0.07	8.50	...	0.06	8.15	...	0.14	6.98	...	0.08
22	12.94	...	...	13.37	0.13	0.04	7.56	...	0.12	8.39	...	0.37	8.54	...	0.14	5.75	...	0.08
23	12.86	0.15	...	13.47	...	0.14	8.09	...	0.16	9.05	0.03	0.06	9.98	...	0.12	7.05	...	0.08
24	12.00	...	...	13.72	...	0.12	...	...	0.24	8.39	0.21	0.13	8.45	...	0.16	6.30	...	0.06
25	13.66	...	0.42	13.82	...	0.10	...	...	0.18	8.73	...	0.12	7.65	...	0.28	5.20	...	0.14
26	12.18	...	0.42	12.97	...	0.18	6.59	...	0.30	*	...	0.12	8.16	0.01	0.07	8.64	...	0.10
27	11.18	...	0.34	...	...	0.11	22.25*	...	0.22	17.08	...	0.16	8.49	0.01	0.05	5.43	...	0.12
28	11.38	0.14	0.22	11.61	...	0.13	19.70	...	0.08	16.74	...	0.22	8.19	...	0.12	7.32	...	0.16
29	12.53	0.07	0.02	11.27	...	0.10	15.76	...	0.14	15.04	...	0.08	6.75	...	0.16	4.34	...	0.08
30	11.82	...	0.16	...	0.08	0.13	14.14	...	0.16	8.38	...	0.12	7.63	...	0.10	6.31	...	0.12
31	...	...	...	11.07	...	0.08	...	...	...	15.53	0.09	0.23	...	...	0.20	...	...	...

*Irrigated.

Moisture Content of Soil, Laramie Experiment Farm, Laramie, Wyoming, 1897.

PLAT NO. 3 -SUBSOILED.

Day	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER		
	Moisture	Rain	Evaporation	Moisture	Rain	Evaporation	Moisture	Rain	Evaporation	Moisture	Rain	Evaporation	Moisture	Rain	Evaporation	Moisture	Rain	Evaporation
	Per c'nt	Inch's	Inch's	Per c'nt	Inch's	Inch's	Per c'nt	Inch's	Inch's	Per c'nt	Inch's	Inch's	Per c'nt	Inch's	Inch's	Per c'nt	Inch's	Inch's
1	....	....	....	10.83	....	0.14	10.87	0.02	0.13	14.09	....	0.12	11.39	0.04	0.12	6.59	....	0.12
2	....	....	....	10.21	....	0.12	10.93	0.06	0.08	13.71	....	0.18	13.70	0.09	0.07	6.05	....	0.22
3	....	....	....	10.83	....	0.11	12.22	0.12	0.12	14.05	0.19	0.19	15.52	0.42	0.10	6.52	....	0.12
4	....	....	....	9.08	....	0.22	10.41	0.01	0.09	11.61	....	0.12	14.09	0.21	0.09	6.38	....	0.06
5	....	....	....	....	....	0.09	11.15	0.02	0.09	11.86	....	0.18	14.97	0.12	0.18	6.43	....	0.18
6	....	....	....	8.49	....	0.23	12.25	....	0.08	7.96	....	0.24	13.79	0.05	0.07	7.07	....	0.10
7	....	....	....	9.09	0.01	0.09	11.45	....	0.10	9.49	....	0.22	11.45	....	0.20	6.22	....	0.14
8	....	....	....	9.02	....	0.20	8.85	0.05	0.17	9.20	....	0.12	12.97	0.14	0.06	4.43	....	0.10
9	....	....	....	9.91	....	0.17	10.71	0.14	0.10	9.86	0.20	0.10	13.37	....	0.04	6.72	....	0.10
10	....	....	....	12.45	0.15	0.08	12.10	0.25	0.19	10.78	0.36	0.08	11.04	0.02	0.08	5.84	....	0.04
11	....	....	....	9.96	....	0.05	12.00	....	0.10	9.82	....	0.42	11.38	....	0.08	8.45	0.31	0.13
12	....	....	....	9.78	....	0.06	9.11	....	0.10	8.80	....	0.04	10.28	....	0.18	7.99	0.01	0.09
13	....	....	....	9.78	....	0.20	....	....	0.10	9.24	....	0.26	9.26	....	0.12	8.78	....	0.06
14	....	....	....	10.02	....	0.14	11.41	....	0.10	8.79	0.10	0.04	10.04	....	0.26	8.51	....	0.06
15	....	....	....	10.30	0.02	0.08	9.61	....	0.30	9.00	....	0.14	8.97	....	0.16	8.39	....	0.12
16	....	....	....	....	0.12	0.02	8.55	....	0.32	8.47	0.01	0.16	10.83	....	0.14	6.75	....	0.14
17	....	....	....	10.00	....	0.14	10.40	....	0.16	6.98	....	0.12	8.68	....	0.14	6.65	....	0.16
18	....	....	....	11.12	0.20	0.12	6.96	....	0.20	6.38	0.10	0.22	9.34	....	0.16	5.86	....	0.12
19	....	....	....	11.54	....	0.16	9.55	....	0.24	7.39	....	0.08	9.33	....	0.20	8.16	....	0.08
20	11.59	....	....	17.35	1.01	0.08	7.95	....	0.18	7.29	....	0.14	6.49	....	0.06	8.75	....	0.08
21	11.03	....	....	13.59	0.12	0.08	7.22	0.05	0.07	8.93	....	0.06	7.90	....	0.14	9.81	....	0.08
22	11.30	....	....	13.91	0.13	0.04	7.90	....	0.12	7.22	....	0.37	8.05	....	0.14	6.42	....	0.08
23	15.09	0.15	....	13.64	....	0.14	6.03	....	0.16	8.40	0.03	0.06	7.36	....	0.12	5.55	....	0.08
24	12.08	....	....	13.95	....	0.12	....	....	0.24	6.97	0.21	0.13	7.49	....	0.16	6.02	....	0.06
25	13.50	....	0.42	11.78	....	0.10	....	....	0.18	8.37	....	0.12	9.65	....	0.28	6.83	....	0.14
26	13.31	....	0.42	12.72	....	0.18	7.44	....	0.30	*	....	0.12	6.40	0.01	0.07	7.08	....	0.10
27	11.43	....	0.34	....	....	0.11	21.15*	....	0.22	16.97	....	0.16	8.62	0.01	0.05	6.48	....	0.12
28	10.09	0.14	0.22	10.43	....	0.13	21.76	....	0.08	16.90	....	0.22	6.90	....	0.12	6.54	....	0.16
29	11.49	0.07	0.02	9.50	....	0.10	16.23	....	0.14	14.79	....	0.08	6.57	....	0.16	8.40	....	0.08
30	10.56	....	0.16	12.27	0.08	0.13	16.37	....	0.16	10.52	....	0.12	7.87	....	0.10	6.95	....	0.12
31	....	....	....	12.23	....	0.08	....	....	....	12.46	0.09	0.23	....	....	0.20	....	....	....

*Irrigated.

UNIVERSITY OF WYOMING.

Agricultural College Department.

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LARAMIE, WYOMING.

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WYOMING SUGAR BEETS.

BY E. E. SLOSSON.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

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Wyoming Agricultural Experiment Station.

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WYOMING SUGAR BEETS.

BY E. E. SLOSSON.

So many inquiries have been received by this Station asking whether sugar beets can be raised successfully in Wyoming and whether it is possible to establish factories here, that the earlier bulletins on the subject have long been out of print and it becomes necessary to issue another bulletin to include a summary of all the experiments made in raising sugar beets, and to give sufficient data on the sugar beet industry for our farmers and land owners to decide on its practicability.

The Station has raised sugar beets on the experiment farms in different parts of the state for seven years, and besides this, sugar beet seed has been distributed free of charge almost every year to all farmers who would agree to try raising beets and would send samples for analysis. The results obtained by the free distribution of seed have been uncertain and unsatisfactory. Not very many farmers have expressed a willingness to coöperate with the station in this way, and of those who were given seed and agreed to report and send samples, only a small proportion, from a tenth to a third, have been heard from since. We are therefore all the more grateful to those who have complied with the conditions and thus assisted the Station in its efforts to give the experiments wider range.

This year a limited amount of sugar beet seed will be distributed, but care will be taken that it is sent only to responsible parties who will give it a fair trial and report results whether good or bad.

The following tables give all the experiments in sugar beet culture in Wyoming of which we have record. Although they are few, yet, covering as they do so many years of varying weather and representing all the principal agri-

cultural regions of the state, they give a basis for a pretty accurate judgment of what may be expected of this branch of agriculture. Some of the analyses of each year, and all of those of 1897, were made by the Department of Agriculture at Washington. The rest were analyzed in the Chemical Laboratory of the University of Wyoming.

Yields reported by private parties are all excluded, as some of them are manifestly incorrect and there was no way of judging how accurate the rest were. The yields from the experiment farms were calculated from actual weights of the crop from plats of known area. The average does not, however, represent exactly what may be expected in practice, for beets of many varieties, some of them inferior, were grown, and several methods of cultivation and kinds of soil were tested. Since the unsuccessful are included with the successful, the average yield is less than if approved seed and methods of cultivation had been used. On the other hand, in part of the experiments only small plats were used, which gives an inaccurate, generally excessive, yield per acre. On the whole, the averages of yields are believed to give a fair, though only approximate, idea of the production of sugar beets in the localities represented by the experiment farms during the period of seven years.

EXPLANATION OF TERMS.

In analyzing beets the juice is extracted and its specific gravity determined; that is, its weight compared with an equal volume of water. From this is calculated the per cent of solid matter, including sugar, in the juice. The amount of sugar is then determined by the polariscope. Since about 95 per cent of the beet is juice, subtracting five per cent of this gives the per cent sugar in the beet. Dividing the per cent sugar in the juice by the total solids in the juice gives the "purity." For example, if there are 20 per cent of solid matter and 15 per cent of sugar, the purity is 15 divided by 20, or 75.

Results of Sugar Beet Culture in Wyoming.

Year	Place.	Grown by	Variety	Yield, tons per acre	Per cent sugar in beets	Purity
1891	Laramie	Experiment Farm	La Plus Riche	3.3	11.1	67.0
"	"	" "	" "	"	15.3	81.7
"	"	" "	Kleinwanzlebener	3.9	12.2	69.5
"	"	" "	"	"	15.1	83.4
"	"	" "	Desprez	3.5	13.9	71.5
"	"	" "	"	"	14.7	83.1
"	"	" "	Vilmorin Improved	4.3	15.1	68.5
"	"	" "	" "	"	15.0	77.0
"	"	" "	" "	"	16.0	82.7
"	"	" "	Kleinwanzlebener	4.1	13.3	65.7
"	"	" "	"	"	15.1	80.3
"	"	" "	"	8.9	16.0	70.0
"	"	" "	"	"	10.3	74.1
"	"	" "	"	"	13.3	65.7
"	"	" "	"	"	13.8	82.4
"	"	" "	Vilmorin Improved	...	11.9	65.7
"	"	" "	" "	...	12.1	74.7
"	"	" "	Silesian	3.1	12.4	78.9
"	"	" "	"	"	14.1	75.8
"	Lander	" "	...	...	12.8	80.7
"	Sundance	" "	Simon's La Grande	5.8	16.9	82.0
"	"	" "	" "	"	15.5	79.6
"	"	" "	" "	"	19.0	85.6
"	"	" "	...	"	14.0	75.8
"	"	" "	...	"	16.3	78.2
"	"	" "	...	"	14.8	77.1
"	"	" "	White French	"	13.7	77.4
"	"	" "	" "	"	15.7	79.1
"	"	" "	" "	"	15.3	84.1
"	"	" "	Desprez	"	14.7	77.1
"	"	" "	"	"	18.0	78.4
"	"	" "	"	"	17.7	79.5
"	"	" "	White French	...	12.5	68.8
"	"	" "	" "	...	11.1	67.6
"	"	" "	" "	...	15.9	73.7
"	Laramie	Terry Fee	Vilmorin Improved	...	14.5	75.4
"	"	" "	" "	...	12.4	73.4
"	"	" "	" "	...	12.5	73.5
"	"	" "	" "	...	13.2	75.7
"	"	Experiment Farm	Lane's Improved	7.0	12.8	75.8
"	Saratoga	" "	Vilmorin Improved	17.4	15.1	80.1
"	"	" "	" "	"	15.5	82.7
"	"	" "	" "	"	11.4	77.9
"	Cooper	E. S. R. Boughton	...	...	13.8	77.4
"	"	" "	...	...	16.0	78.4
"	"	" "	...	...	13.0	72.9
"	"	" "	...	...	15.8	77.8
"	"	" "	...	...	19.9	80.7
"	"	" "	...	...	14.4	70.4
"	Wheatland	Experiment Farm	Kleinwanzlebener	...	16.9	88.2
"	"	" "	"	...	14.1	84.3
"	"	" "	"	...	13.0	80.7
"	"	" "	...	1.8	22.5	89.9
"	"	" "	...	"	21.3	90.1
"	"	" "	Vilmorin Improved	7.2	19.5	88.0
"	"	" "	" "	"	22.0	86.9
"	"	" "	" "	"	21.6	84.3
"	Laramie	A. Fisher	...	...	20.8	86.6
"	"	" "	...	...	13.7	74.7

Results of Sugar Beet Culture in Wyoming—(Continued.)

Year	Place.	Grown by	Variety	Yield, tons per acre	Per cent sugar in beets	Purity
1891	Sheridan	Experiment Farm	. . .	. . .	17.5	85.5
"	"	" "	. . .	. . .	14.4	86.6
"	Lander	" "	. . .	. . .	17.8	85.6
"	"	" "	. . .	. . .	18.2	85.3
"	Sundance	" "	French	. . .	11.3	77.5
"	Crook County	C. E. Lincoln	Vilmorin Improved	. . .	13.3	70.8
"	" "	" "	Kleinwanzlebener	. . .	14.9	73.3
"	Johnson County	S. Morgridge	French	. . .	13.3	77.2
"	Laramie County	R. M. Walker	"	. . .	9.4	72.5
"	" "	A. C. Hubbard	Vilmorin Improved	. . .	14.2	77.2
"	" "	" "	Kleinwanzlebener	. . .	12.8	70.2
"	Sheridan	Experiment Farm	. . .	. . .	13.8	80 0
1892	Laramie	Experiment Farm	Vilmorin Improved	8.6	8.8	64.1
"	"	" "	" "	"	10.0	70.5
"	"	" "	" "	"	11.1	72.4
"	"	" "	" "	"	12.7	74.9
"	"	" "	" "	"	12.6	76.0
"	"	" "	" "	"	13.6	74.1
"	"	" "	" "	"	12.6	71.9
"	"	" "	" "	"	14.2	76.1
"	"	" "	Kleinwanzlebener	9.3	8.6	64.3
"	"	" "	"	"	9.2	70.3
"	"	" "	"	"	12.6	78.3
"	"	" "	"	"	13.1	77.2
"	"	" "	"	"	13.1	74.2
"	"	" "	"	"	16.1	78.6
"	"	" "	Lane's Imperial	10.8	15.6	81.1
"	"	" "	" "	"	12.5	72.9
"	"	James King	Kleinwanzlebener	. .	16.1	77.8
"	"	" "	"	. . .	15.2	75.0
"	Saratoga	Experiment Farm	"	8.0	12.7	71.2
"	"	" "	"	"	12.0	69.6
"	"	" "	"	"	18.3	83 3
"	Wheatland	" "	"	11.8	16.9	84.5
"	"	" "	"	"	14.2	82.3
"	"	" "	"	"	14.8	81.8
"	"	" "	"	"	20.8	90.5
"	"	" "	Vilmorin Improved	14.6	18.7	82.6
"	"	" "	" "	"	16.0	87.7
"	"	" "	" "	"	21.5	86.9
"	"	" "	Lane's Imperial	10.9	14.9	78.7
"	"	" "	" "	"	14.8	86.2
"	"	" "	" "	"	14.0	81.5
"	"	" "	" "	"	19.0	87.7
"	Sundance	" "	Kleinwanzlebener	4.3	14.2	67.6
"	"	" "	"	"	13.2	71.8
"	"	" "	White French	6.6	9 6	66.2
"	"	" "	Vilmorin Improved	2.3	14.6	82.1
"	"	" "	" "	"	14.0	76.7
"	"	" "	Lane's Imperial	6.5	11.4	63.3
"	"	" "	" "	"	9.5	60.6
"	Sheridan	" "	French Yellow	19.0	15.3	74.0
"	"	" "	" "	"	19.6	78.9
"	"	" "	Lane's Imperial	12.5	17.1	77.6
"	"	" "	French White	15.1	21.6	84.6
"	"	" "	" "	"	21.4	84.3
"	"	" "	Kleinwanzlebener	12.0	23.0	86.6
"	"	" "	"	"	21.0	86.6

Results of Sugar Beet Culture in Wyoming—(Continued.)

Year	Place	Grown by	Variety	Yield, tons per acre	Per cent sugar in beets	Purity
1892	Sheridan	Experiment Farm	Vilmorin Improved	20.1	19.9	85.4
"	"	" "	" "	"	18.6	87.9
"	"	" "	Lane's Imperial	12.5	18.3	85.9
"	"	" "	" "	"	17.1	87.6
"	"	" "	French Yellow	19.0	18.2	74.4
"	"	" "	French White	...	17.2	87.2
"	Hatton	C. A. Chase	....	...	20.8	86.2
"	Torrey	Ed Cussack	Vilmorin Improved	...	17.1	76.6
"	"	" "	" "	...	20.9	83.8
"	Forks	A. D. Brown	Kleinwanzlebener	...	16.3	78.3
"	"	" "	"	...	13.3	74.4
"	Mountain View	M. Manley	Vilmorin Improved	...	20.6	85.5
"	" "	" "	" "	...	18.3	79.9
"	Leo	J. W. Bennett	Kleinwanzlebener	...	11.7	75.6
"	"	" "	"	...	12.0	82.2
"	"	" "	"	...	13.9	76.8
"	Inyan Kara	S. A. Young	Vilmorin Improved	...	17.1	72.6
"	Beaver	Chas. Rice	" "	...	23.3	85.3
"	Ohlman	R. Niver	Kleinwanzlebener	...	19.9	87.1
"	"	" "	"	...	21.6	86.0
"	Laramie	R. Henke	"	...	17.3	85.5
"	Cheyenne	H. H. Hood	....	...	15.0	71.7
"	"	" "	....	...	14.1	72.9
"	Big Horn	R. M. Hays	....	...	21.2	87.0
"	" "	" "	....	...	19.0	85.6
1893	Laramie	Experiment Farm	Vilmorin Richest	...	13.1	78.8
"	"	" "	Kleinwanzlebener	...	12.5	75.9
"	"	" "	Knauer Imperial	...	12.3	75.9
"	Sybille	Alfred Bridger	Vilmorin Richest	...	15.7	79.1
"	Saratoga	Experiment Farm	Kleinwanzlebener	16.3	16.0	81.5
"	"	" "	Improved Bulteau	13.6	16.8	83.9
"	"	" "	" "	"	20.1	82.7
"	"	" "	Vilmorin Richest	16.3	15.0	85.0
"	"	" "	" "	"	21.4	86.1
"	"	" "	Kleinwanzlebener	"	15.9	84.8
"	Sundance	" "	"	3.1	13.4	72.3
"	"	" "	"	3.0	17.1	76.0
"	"	" "	"	"	15.4	76.0
"	"	" "	"	"	13.8	73.7
"	"	" "	Vilmorin Richest	3.8	14.9	72.0
"	"	" "	" "	"	16.9	87.8
"	Lander	" "	" "	20.5	15.4	77.4
"	"	" "	Knauer's Imperial	21.0	15.6	80.9
"	"	" "	Kleinwanzlebener	24.0	15.1	78.7
"	"	" "	Improved Bulteau	20.5	15.0	83.1
"	"	" "	" "	"	14.9	85.4
"	Wheatland	" "	Vilmorin Richest	6.2	17.7	86.9
"	"	" "	" "	"	21.6	86.1
"	"	" "	Knauer's Imperial	6.8	16.9	85.1
"	"	" "	Kleinwanzlebener	"	21.2	86.4
"	"	" "	Improved Bulteau	6.0	21.8	89.1
"	Sheridan	" "	" "	10.5	13.0	78.0
"	"	" "	" "	"	17.0	86.3
"	"	" "	" "	"	17.1	82.0
"	"	" "	Kleinwanzlebener	17.0	16.3	86.1
"	"	" "	"	"	16.8	78.9
"	Afton	John Astle	Desprez No. 2	...	12.9	81.5
"	Mountain View	M. Manley	Kleinwanzlebener	...	13.1	72.4

Results of Sugar Beet Culture in Wyoming—(Continued.)

Year	Place	Grown by	Variety	Yield, tons per acre	Per cent sugar in beets	Purity
1894	Laramie	Experiment Farm	Kleinwanzlebener	7.9	15.6	80.4
"	"	" "	Vilmorin Improved	12.6	16.9	84.4
"	"	" "	White Silesian	8.6	15.0	81.0
"	"	" "	New Danish	...	12.8	75.4
"	"	" "	Meltee	14.0	15.8	81.7
"	Sheridan	" "	Vilmorin Improved	11.1	21.6	80.3
"	"	" "	Kleinwanzlebener	9.8	20.7	85.8
"	"	" "	White Silesian	8.5	19.0	88.6
"	"	" "	Meltee	15.6	20.6	89.6
"	Sundance	" "	White Silesian	5.3	...	...
"	"	" "	Vilmorin Improved	2.9	...	...
"	"	" "	Kleinwanzlebener	4.3	...	...
"	Wheatland	" "	Knauer's Imperial	11.0	...	...
"	"	" "	Kleinwanzlebener	12.0	...	...
1895	Laramie	Experiment Farm	Kleinwanzlebener	5.8	13.9	80.7
"	"	" "	Improved Keilholz	1.5	11.7	75.0
"	"	" "	Improved Lion	3.7	13.7	77.0
"	"	" "	Keilholz Imperial	5.3	...	...
"	Sundance	" "	Kleinwanzlebener	6.2	...	...
"	Lander	" "	"	5.4	...	...
"	"	" "	"	23.2	...	...
"	"	" "	"	20.3	...	...
"	"	" "	Vilmorin Improved	19.6	...	...
"	"	" "	Hayne's Improved	17.4	...	...
"	"	" "	Kleinwanzlebener	...	...	...
1896	Laramie	Experiment Farm	Kleinwanzlebener	9.4	...	...
"	"	" "	Ertragreicher	0.0	...	...
"	"	" "	Improved Keilholz	4.6	...	...
"	"	" "	Keilholz Imperial	8.4	...	...
"	"	" "	Keilholz Lion	6.2	...	...
"	"	" "	Zucherreicher	0.0	...	...
"	Sheridan	" "	...	5.9	...	...
"	"	" "	...	7.3	...	...
1897	Laramie	James King	Kleinwanzlebener	...	12.2	77.3
"	"	Experiment Farm	"	7.2	19.7	88.1
"	"	" "	"	5.8	19.0	89.2
"	"	" "	"	6.4	20.3	92.1
"	Centennial	A. L. Foster	"	...	22.3	...
"	Fenton	W. Thayer	"	...	15.8	83.4
"	Shell	Peter Enders	"	...	18.5	85.0
"	Fenton	W. Thayer	"	...	22.7	87.2
"	Bonanza	O. C. Morgan	"	...	20.4	85.3
"	"	J. E. Heron	"	...	12.0	70.2
"	Burlington	W. E. Guylamp	"	...	22.6	...
"	Coreyhurst	J. M. Carey	"	...	16.0	84.0
"	Douglas	Robt. Fryer	"	...	17.9	83.5
"	"	J. A. Brockway	"	...	24.3	...
"	"	Alex. Brockway	"	...	17.0	77.7
"	"	Willard Virdin	"	...	18.1	86.3
"	"	J. M. Brockway	"	...	19.0	83.2
"	"	David Brockway	"	...	15.8	...
"	Orin	F. M. Haynes	"	...	16.3	80.2
"	Douglas	Robt. Fryer	"	...	15.6	80.4
"	Sundance	Lawrence Mauch	"	...	17.1	...
"	Lander	Experiment Farm	"	...	12.5	72.0
"	Buffalo	J. A. Fisher	"	...	11.3	75.2

Results of Sugar Beet Culture in Wyoming—(Continued.)

Year	Place	Grown by	Variety	Yield, tons per acre	Per cent sugar in beets	Purity
1897	Buffalo	J. A. Fisher	Kleinwanzlebener	...	9.1	...
"	"	E. P. Gossett	"	...	13.4	76.9
"	Wheatland	W. J. Hooston	"	...	15.5	79.5
"	"	G. W. Watkins	"	...	17.1	86.9
"	"	S. V. Moody	"	...	16.8	85.8
"	"	G. F. Frederick	"	...	14.7	81.0
"	Freeland........	C. M. Cheney	"	...	17.3	78.6
"	"	" "	"	...	19.6	...
"	Dayton	R. A. Frazier	"	...	16.2	...
"	"	" "	"	...	19.6	...
"	Sheridan........	Experiment Farm	"	12.4	18.0	89.1

Comparative Table Showing Results of Sugar Beet Culture on the Experiment Farms from 1891 to 1897, Inclusive.

EXPERIMENT FARM.	Average yield, tons per acre	Average per cent sugar in beets	Average purity
Lander..........	19.24	15.25	81.01
Laramie..........	5.09	13.26	75.50
Sheridan..........	13.25	18.36	83.93
Sundance..........	4.50	14.76	75.34
Wheatland..........	9.61	17.85	85.20

DISCUSSION OF RESULTS.

From this table it will be seen that the region about Sundance, when irrigation is not possible, and the elevated plateau along the Union Pacific represented by Laramie, do not give satisfactory results. While the yield and quality of the beets given in the table is below what might be expected in farming in the ordinary way, yet large crops cannot be depended upon in either of these localities. The Lander valley gives remarkably good results, but on account of lack of railroad facilities it would be impracticable to establish a factory there at present. For the same reason the Big Horn valley must wait, although from its resemblance to the Sheridan district and from the good results obtained this year and reported in the preceding pages, it would prove well suited to beet growing. The Wheatland

and Sheridan farms have given every year good yields and the beets are of extraordinary richness and purity, and there seems to be no reason why factories in their vicinity should not be successful.

Irrigated land has a great many advantages over land depending on the caprice of nature for its water supply. Sugar beets require a large and continuous supply of water during the early part of the growing season, while abundant rains in the autumn lower the sugar content very materially. Many instances have occurred where crops were severely injured by late rains, and the newspapers report that one of the largest sugar factories in the west will remain idle this season on account of drought. Sugar beets are injured by too warm weather, but require an abundance of sunshine, of which in this country there is no lack. One disadvantage of the climate of Wyoming is the shortness of the season, on account of which beets do not always have time to fully mature, and crops cannot be put in at different times so as to secure succession of ripe beets at the factory while in operation. It would probably be necessary to put most of the beets in silos. An objection often raised against growing beets in the arid region is the presence of alkali. According to our experience, the alkali in this state, which consists chiefly of sodium and magnesium sulphate, does not interfere with the growth of the beets or perceptibly impair their quality.. Good crops of satisfactory richness have many times been grown in ground strongly impregnated with soluble salts, and in 1897 an experiment bearing directly on this point was carried out on the Laramie farm. Three plats were planted; two of them were of the best land of the farm, and of these one was cultivated in the ordinary way and the other was subsoiled. The third plat was of the worst alkali land that could be found and on which most crops could not be grown at all. The results were as follows:

	Yield	Per cent sugar in beets	Purity
Alkali land	7.2	19.0	89.2
Good land, subsoiled	6.4	19.7	88.2
Good land, not subsoiled	5.8	20.3	92.7

IMPORTANCE OF THE BEET SUGAR INDUSTRY.

The rise of the beet sugar industry is a remarkable example of what can be accomplished by science applied to agriculture. In the beginning nothing could seem more hopeless than that sugar beet could compete with cane sugar. The beets contained only about six to eight per cent of sugar, the impurities could only be removed by difficult chemical processes, and to grow the beets properly required skilled and expensive labor. The sugar cane, on the contrary, was rich and grew with tropical luxuriance, while the harvesting and sugar making was done by the cheapest labor in the world. Today out of 7,000,000 tons of sugar produced annually, about 5,000,000 tons are made from beets. Within the last ten years there has been an increase of 50 per cent in the world's production of sugar and in consequence of its lower price a corresponding increase in consumption. The United States consumes annually about 2,000,000 tons, or 64 pounds a year for each man, woman, and child. At present about 84 per cent of this is imported, but if the beet sugar industry continues to develop we will in time be growing our own supply of sugar.

The following figures show the amount of sugar produced from cane and beets during the past four years in the United States:

	Beet	Cane
1894-5	20.000 tons	317.000 tons
1895-6	30.000 "	237 000 "
1896-7	40.000 "	275.000 "
1897-8	70.000 "	287.000 "

To supply the United States with sugar from beets would require a million acres of that crop and 500 facto-

ries, so there is no danger of over-production. Whether the price of the product will be much lower in the future than it is now depends, of course, on competition, invention, and legislation, and it would be unsafe for anyone to make a prediction in regard to it.

PROCESS OF MANUFACTURE.

The conditions under which a beet sugar factory would be successful can be better understood if a brief description is given of the process of extracting the sugar from the beets. The beets, on being received at the factory, are sampled, analyzed, and the tare or deduction for dirt determined. They are then floated in a flume to the washer and after being thoroughly cleaned are sliced into thin triangular pieces known as cossettes. These are packed into a diffusion battery consisting of ten to fourteen cells holding about two tons each. A continuous stream of hot water is passed through the battery in such a way that the fresh water enters the cell where the cossettes are most nearly exhausted. When all the sugar has been extracted in this way the cossettes are pressed and used as cattle food. The water extracts from the beets not only the sugar but also a number of impurities which must be gotten rid of before crystallizing out the sugar. The juice is first treated with two or more per cent of slaked lime and the excess of lime precipitated by passing in carbonic acid gas. After filtering under pressure, the juice is again treated with a smaller quantity of lime and finally with sulphurous acid gas to completely decolorize it. By evaporating off the water from the purified solution sugar is obtained. This process is not, however, as simple as it seems, for it would take too long to evaporate it at low temperature, while if it were boiled the sugar would burn. This difficulty is obviated by reducing the pressure and boiling off the water at low temperature in a partial vacuum. This is done in a series of three or four

tanks, the steam from one serving to boil the next. The final evaporation is done in a large "vacuum pan," holding some thirty-five tons, and when the crystals of sugar have become of the proper size the sugar is separated from the molasses by a centrifugal machine and dried.

PRICES PAID FOR BEETS.

Under present conditions sugar making pays a good profit to both manufacturer and farmer. A sugar factory of average capacity pays out thirty or forty thousand dollars in wages during the season and farmers receive about four dollars a ton for the beets. The price paid for beets usually varies with their quality, since it costs more to extract the sugar from poor beets than from rich ones, and the manufacturers make great efforts to induce the farmers to work for quality rather than quantity. Two things are taken into consideration, the total amount of sugar in the beets and the purity of the juice. At the Nebraska factories this year the rates are as follows:

12 to 14 per cent sugar, purity not less than 78.......$4.00
14.5 to 15.4 per cent sugar, purity not less than 78.... 4.25
15.5 to 16.4 per cent sugar, purity not less than 78.... 4.50
etc., etc.

A reduction of 50 cents per ton for each per cent of sugar below 12, and a reduction of 15 cents a ton for each degree of purity below 78. No beets are received containing less than 10 per cent sugar and of less than 73 purity.

The Alamitos and Chino, California, factories pay $3.00 and $3.35 a ton for 12 per cent beets, with 25 cents a ton increase for each per cent above 12. In order to maintain a high quality of beets the seed is grown only from pedigreed beets whose sugar content is determined by actual analysis. The beet seed is mostly imported at present and is supplied free by the factory at the rate of 15 to 20 pounds to the acre.

REQUIREMENTS OF A SUGAR FACTORY.

The manufacture of beet sugar requires large capital, expert control, and efficient management. The plant is expensive,the working season is short,only about 100 days,and the margin of profit is small in proportion to the amount of the product. The cultivation of the sugar beet requires more intelligent farming than is customary in the United States, and for the first two or three years after the establishment of the factory the education of the farmers in the vicinity is an important part of the work. Small factories do not pay and the tendency in this country is toward building larger factories each year. A factory capable of working 350 or 400 tons of beets a day is as small as is profitable and will cost about $300,000 to $400,000. To supply such a factory 3,000 to 5,000 acres are required, most of which must be within easy hauling distance. The beets can be shipped by railroad a short distance if cheap enough rates can be secured. They should be delivered day by day as the factory requires them, to avoid storage, and should not be allowed to freeze. There must be an abundant supply of pure water. About 2,000,000 gallons a day is used by a factory of the size under discussion. From 45 to 50 tons of coal are used every day and several tons of coke for burning the limestone. At Chino, California, where oil is used for fuel, about 80,000 barrels are required for the season. To supply the lime for purification, twenty or twenty-five tons of limestone are burned per day.

LOCATION OF A FACTORY IN WYOMING.

The question is often asked of the Station whether a sugar factory would be profitable in some particular part of the state, and these figures are given so that people can calculate for themselves the probable success of such an enterprise. It is evident that a locality to support a factory must not only have a sufficient amount of

land suitable for growing good beets, but must also have railroad facilities and a supply of coal, lime, and water in the immediate vicinity. In a state undeveloped, and, we may even say, unexplored, as Wyoming is, it is not possible to say how much of the state will be found suited to this industry, but it is not making any invidious distinctions to point out that there are at least two localities that meet all the requirements. These are the irrigated land near Wheatland and Douglas, and that in the vicinity of Sheridan. It should also be mentioned that some of the chemicals used in the purification of sugar could also be obtained within the bounds of the state. Sal soda, of which some 6,000 pounds are required, can be prepared at Green River by simple evaporation. About 30,000 pounds of sulphur are also needed and could be obtained from Uinta county with very little trouble.

The duty of the Experiment Station is to investigate a proposed branch of agriculture and report to the people the facts discovered, whether favorable or unfavorable. Experimenting on sugar beet culture has been carried on continuously ever since the Station was established, and four bulletins have been issued on the subject. If some localities are not represented it is not the fault of the Station, for offers of free beet seed for experimental purposes have been made almost every year, in the newspapers of the state. This year a smaller amount of beet seed is on hand for distribution to those who are willing to try it and send samples for analysis. Directions for the culture of the sugar beet are appended to this bulletin. A crop of sugar beets is valuable even when there is no factory. They are better for table use than the red beet and are raised on a large scale in many places for cattle food. Five thousand Wyoming cattle were fattened in Nebraska one year on sugar beets raised for that purpose.

The Station will be pleased to coöperate with any lo-

cality which contemplates establishing a sugar factory, either by a visit of some member of the staff to lecture and make a detailed reconnoissance, or by giving such information as may be desired as to machinery and where it can be obtained.

LITERATURE OF THE SUBJECT.

Those who are interested will find the following publications useful and reliable: U. S. Department of Agriculture, "The Sugar Beet," Farmer's Bulletin No. 52 (free.) Most of the Stations in the sugar beet belt have issued bulletins on the subject this year which can be had on application to the respective stations. Bulletin No. 40 of the Illinois Station, Urbana, Ill., and Bulletin No. 135 of the New York Station, Geneva, N. Y., give a good deal of general information. The periodicals "The Sugar Beet," Philadelphia, (monthly), and "The Louisiana Planter," New Orleans, (weekly) are of value both for articles and advertisements. A pamphlet, "American Beet Sugar," by W. H. Holabird, Los Angeles, California, gives good pictures of the manufacture. "The Sugar Beet," by Ware (H. C. Baird, Philadelphia), and "Sugar," by Myrick (Orange Judd Co., Chicago), are among the best books on the subject.

Method of Cultivation.

BY B. C. BUFFUM.

SOIL:—Take the best soil on the farm. A sandy loam is best, but do not use land so sandy that it shifts with the wind or dries out too much. The soil should be deep and with good drainage. If it has a dressing of stable manure, so much the better, especially if it was applied to a crop last year. If applied this year, do not put on too much. Land plowed last fall is preferable. The earlier and deeper it is plowed the better. It should be plowed long enough before seeding to allow it to settle. Before seeding, harrow thoroughly to make a well pulverized, mellow seed-bed, and to kill all young weeds.

PLANTING:—The seed should be planted in May; from the 10th to the 20th is recommended, if the soil is in the right condition to work. If the soil is very dry or likely to become so, it is well to leave a shallow furrow between each row of seed, so that the plants may be irrigated up, but this should not be resorted to unless absolutely necessary. If obliged to irrigate to bring the seed up, do not allow the soil to dry out and form a crust. Cultivate the surface as soon as the plants are up enough to show the rows distinctly. Plant the seed in rows from fifteen to twenty inches apart and from one to three inches deep. A hand seed drill is best. After planting, the rows should be tramped upon to firm the soil around the seed. If planted by hand, drop the seed in shallow furrows, cover with a hand plow or hoe, and tramp the soil, to firm it around the seed.

CULTIVATION:—This should begin as early as possible and should occur often enough to keep down all weeds

and keep the ground mellow. Beets require thorough cultivation. After trimming, during June and July, the cultivation should reach a depth of six inches. Cultivate shallow as soon after irrigating as the ground can be worked, and cultivate deep before the next irrigation. Care should be taken not to break the leaves or to throw the soil against the plants, hilling them up, as they need flat cultivation to give them all the air and sunshine they can get.

THINNING:—When the beets have developed four leaves, they should be thinned. This is best done by first going through the rows with a hoe, cutting out from four to six inches of beets, and leaving bunches between that contain a number of plants. After bunching in this way, thin by pulling out all but the largest and healthiest beet in each bunch.

IRRIGATION:—Beets require considerable water during the growing period in June, July, and August. They should not be kept so wet that the ground becomes sour or soggy, or contains so much water that it cannot be kept in a good state of tilth and well aerated by cultivation. Nor should the soil be allowed to get so dry that all the leaves wilt. Irrigate in furrows made between the rows in such a way that the water will not flood over or around the crowns of the beets. Cultivate as soon after each irrigation as the ground gets dry enough to work. Run the cultivator shallow to break up the surface crust.

Do not irrigate until the beets show unmistakable signs of needing moisture, as irrigating too soon or too often is apt to spoil both the shape and quality. When the bottom leaves begin to wilt and the top ones to turn a dark green, they need water. If the tops have a light greenish yellow appearance, they have been kept too wet. They probably will need from three to five irrigations. The number of times necessary will depend upon the supply of moisture. They should not be irrigated later than the last of August,

as the beets require dry, sunny weather during September, to ripen and store up a large per cent of sugar in the juice.

HARVESTING:—The beets should be mature about the first of October. Ripening is indicated by the outer leaves turning yellow and dying. They should be harvested in October before hard freezing weather. If a hard freeze occurs, they should not be taken from the ground until thawed out, as in this way the frost will leave the beets gradually without destroying them. Loosening the soil between the rows with a narrow plow will enable the beets to be pulled without bruising them. Cut off the tops squarely with a little of the rough portion of the beets. The best size is from one to three pounds. If they weigh over four pounds they are apt to be poor in sugar. Beets may be stored in root cellars or in pits in the ground, like potatoes or other root crops. They keep better if covered with soil which comes in contact with the beets, as this prevents wilting. If stored in pits for any length of time, they should be covered with five or six inches of soil, then a layer of straw of the same thickness, and more soil over the straw as the weather gets very cold. Where placed in pits or silos, a hole must be left in the top for ventilation, filling it with straw or sacks, instead of with soil, as cold weather comes on.

Directions for taking samples for analysis will be printed on report blanks furnished with the seed.

UNIVERSITY OF WYOMING.

Agricultural College Department.

WYOMING EXPERIMENT STATION,

LARAMIE, WYOMING.

BULLETIN NO. 37.

JUNE, 1898.

THE STOOLING OF GRAINS.

BY B. C. BUFFUM.

Bulletins will be sent free upon request. Address: Director Experiment Station, Laramie, Wyo.

Wyoming Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

President of the University of Wyoming.

FRANK PIERREPONT GRAVES, Ph. D., Litt. D., LL. D.

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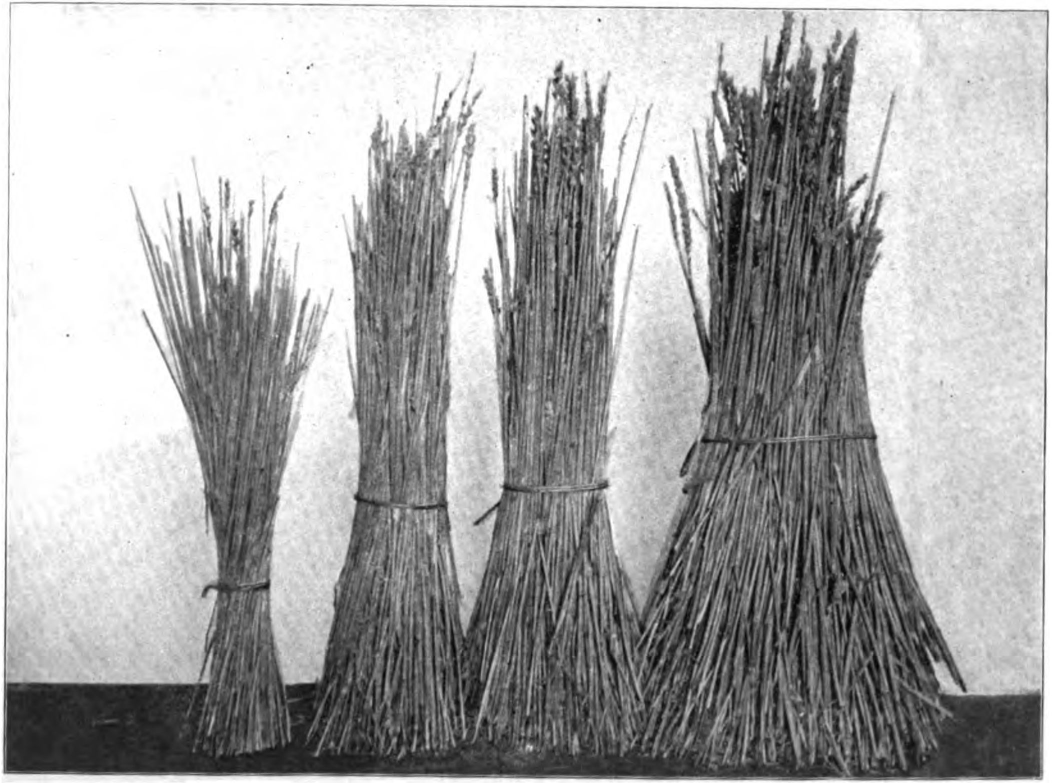


Stools 1 inch, 2 inches, 4 inches, and 12 inches apart.

CHILI WHEAT.

Each bundle shows straws produced by 50 seeds

THE STOOLING OF GRAINS.

B. C. BUFFUM.

We believe the growing of small grains will always constitute an important part of general farm practice under irrigation in our state.

The average altitude for the state is placed at 6,000 feet. The climate is arid and the consequent lack of moisture and clouds in our rarefied atmosphere produces cool nights and comparatively short seasons. In any except our lower altitudes these conditions make the production of corn either impossible or unprofitable. When properly handled, wheat, oats, and barley are our most remunerative cereal crops. In addition to their more common uses, these grains will form the basis of our food rations for live stock. It may be expected therefore that the shortening of the open range along with the development of a more general agriculture and the increase of home feeding will tend to make the production of small grains of greater rather than of less importance.

The soils, altitude, and climatic conditions differ greatly in our somewhat widely separated agricultural sections and the camparative effects of these variations, in the natural order of things upon our staple crops are of importance in determining the best methods of culture to be pursued. We believed our experience in growing small grains indicated that heavier seeding was required at high altitudes, other conditions being equal, than at low ones. Is it true that 120 pounds of seed per acre will produce a heavier and better crop of oats than half that amount and if so why is it true? The first object then of the experiments reported

in the following pages was to study the effects of the different conditions in our state upon the life history of the plants themselves which would indicate in a general way differences in methods of treatment necessary to produce maximum yields.

In looking over our station literature we find but little data upon the tillering of grains and the conditions which change, one way or another, this important function.* A dozen years ago Prof. A. E. Blount, then with the Colorado station began advocating thin sowing in the west. He says "This habit of stooling in wheat, rye, barley, and oats should in all such plants be respected." He thought a bushel of good seed wheat sown evenly over an acre of good soil in good condition would be about twice too thick.†

Quite extensive investigations of different amounts of seed per acre of wheat, oats, and barley have been reported by several of the Experiment Stations in other states. Those in Indiana, Illinois, Ohio, Kansas, and other humid states indicate that heavy seeding is much better than light. We should bear in mind the fact however that results of this kind obtained in humid states under rainfall and the great difference in soil conditions are not applicable to our agricultural practice under the conditions prevailing in the arid region. The work in adjoining arid states would be of more value to us. In Nevada about 70 pounds of wheat per acre has given the best results, and in Colorado even less than this amount has been advocated.‡

*Ala. Sta. Bul. 2 shows that the number of heads per stool produced by wheat increases with depth of planting. Kans. Sta. Bul. 29 shows some variation in number of stalks per plant in different varieties of oats, and Bul. 59 gives rate of seeding of wheat and number of stalks in 20 feet of row which shows a large increase in number of stalks as less seed is used down to one-half bushel per acre.

†Colo. Sta. Bul. No. 2, pp. 11-12

‡I give a list of the Station bulletins reporting different amounts of seed per acre which have come to my notice Wheat—Ala. Sta. Bul. No. 2; Ind. Sta. Bul. 27, 32, 41, 45, 56, 61; Ohio Sta. Bul vol. 2. No 5; Ill. Sta. Bul. No. 11; Ky. Sta. Bul. No. 36, 42; Ill. Sta. Bul. 22, 34; Kans. Sta. Bul. 33, 59, 71; N. Dak. Sta. Bul. No. 10; Nev. Sta. Bul. No. 27 and Annual Rept., 1895; Oklahoma Sta. Bul. No. 28; Colo. Sta. Bul. No. 2. Oats—Colo. Sta. Bul. No. 2, Ill. Sta. Bul. No. 7, 19, 23, 41; Ohio Sta. Bul. vol. 3, No. 3, vol. 5, No. 1, and Bul. No. 57; Kans. Sta. Bul. No. 29, 42, 54, 63; Ind. Sta. Bul. No. 50, 55; Minn. Sta. Bul. No 40. Barley.—N. Dak. Sta. Bul. No. 11; Colo. Sta. Bul. No. 2, 30, 40.

STOOLING EXPERIMENTS.

GENERAL CONCLUSIONS.

1. The number of mature heads produced by each seed of wheat, oats, or barley varies greatly with the locality, season, and distance apart seeds are planted.

2. The number of heads and the amount of grain produced by each seed increases rapidly with the greater amount of room accorded each.

3. When planted wide distances apart the straw is shorter than when thickly planted but, on account of the greater number of adventitious stems produced and the larger and more numerous leaves, there is more straw in proportion to the amount of grain where there is plenty of room.

4. Where given too much room many more stems are produced than will mature heads. On account of the continuous growth from the crown of the stool during the summer the grain is late in maturing, does not fill well, and, as a whole produces light, inferior grain.

5. Larger heads are produced upon grain planted more than one inch apart though all the heads may not be as uniform in size. The number of seeds in the largest heads produced increases rapidly with increased distances between plants.

6. While more grain will be produced by each seed when planted at greater distances than one inch apart the actual amount of grain will be less for the area of land used. Therefore seeding so thinly that there will be less than one plant for each inch of drill row decreases the amount of grain per acre rather than increases it. A study of our experiments seems to indicate that in farm practice sowing seed so plants will be secured about one inch apart

from stools at greater distances apart look taller than the smaller bundles, while the grain in the plats stood almost the same height and the average length of the straw was actually shorter. They look longer in the pictures because in the large bundles it was impossible to keep the bottoms of the straws on the same level.

Before taking the photographs all the mature heads had been removed. The large increase in the number of immature heads, with increase of distance between the stools is apparent, especially in the wheat. Very few undeveloped heads were left in the straw from stools one inch apart. Attention is also called to the comparative fineness of the straw. With a great amount of room large, coarse straws are produced.

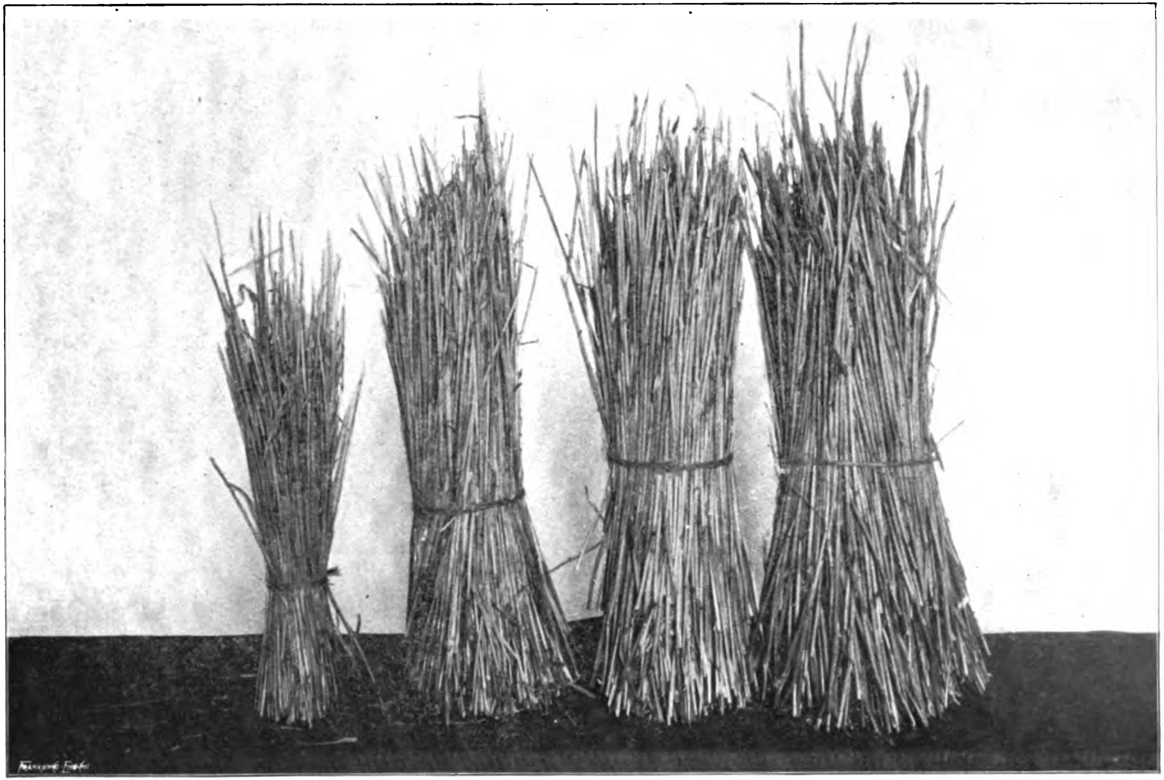
DETAILED REPORT OF EXPERIMENTS.

In 1896 experiments to determine the relative tillering of wheat, oats, and barley were made at five different places, viz: Laramie, Lander, Sheridan, Sundance, and Wheatland. At the close of the season, after having studied the data furnished from the different places it was decided to continue the observations through another season, changing the plan of and adding to the experiments somewhat before attempting to report results.

A brief outline of the instructions for the guidance of each superintendent in 1896, taken from the detailed plans of the season's work, is as follows:

"This experiment will take some time and careful attention but it is important to carry it out alike on each of the farms.

"Seed of wheat, oats, and barley have been hand selected. A smooth seed bed is to be prepared with a garden rake. It is to be free from lumps and mellow to a depth of at least three inches The rows are to be three feet apart.



Stools 1 inch, 2 inches, 4 inches, and 12 inches apart.

MANSHURY BARLEY.

Each bundle shows straw produced by 50 seeds.

All the seed is to be planted two inches deep and the wheat, oats, and barley are to be treated the same.

50 seeds are to be planted 1 inch apart.

50 seeds are to be planted 2 inches apart.

50 seeds are to be planted 4 inches apart.

25 seeds are to be planted 12 inches apart.

"Plenty of room is to be given between each planting so that there will be no danger of getting them mixed. The seeds of each planted are to be counted when they come up. The number of heads in each planting will be counted when the grain is in full head. All are to be treated alike. No hoeing or cultivating will be done near the plants but weeds growing there must be pulled. The following are instructions in regard to planting and the same method is to be followed in each case:

"Take a straight piece of 2x4 about six feet long. With an inch bit bore holes with their centers two inches apart making twenty-five of them. In these holes place pegs to fit, letting them project two inches from the 2x4 and taper each leaving a blunt point one-fourth to one-half inch across.

"When the seed bed is ready set the instrument in the row, press it down until the pegs are imbedded in the soil up to the 2x4, take it up and drop one seed in each hole. This will leave the seeds two inches apart and two inches deep For the seed that are to be one inch apart, after the seed has been planted two inches apart, set the pegs between the holes already planted and make the rest of the holes which when planted will leave the seeds one inch apart. For the seeds to be four inches apart drop one in every other hole.

"Proceed in this manner till all the seeds are planted. After the seeds are dropped and the holes filled turn the 2x4 on its side over the seed and step on it to firm the soil around the seed."

The seed was carefully selected from varieties grown

at Laramie in 1895. In short the treatment of the plants throughout was as nearly the same at each place as possible.

In repeating the experiment in 1897 instead of fifty seeds of each of these grains one hundred seeds were planted. At the time the grain was far enough advanced to count up mature heads fifty stools were selected from the row, taking those where the fewest seeds failed to grow. This gives a record of the heads and grain produced from fifty seeds instead of a less number and eliminates a part of the error arising from greater distances allowed where the seeds did not come up. In addition to the stooling test in rows, small plats were planted with different amounts of seed per acre in order to give more light upon what to expect in actual field practice.

As investigations upon the Sundance and Wheatland farms were not continued in 1897 the experiments were only carried out at Laramie, Lander and Sheridan.

The seed for this experiment was selected and different amounts weighed out for each series of plats. The oats were treated for smut in the copper sulphate solution. They were left in too long and consequently failed to germinate when planted. At Sheridan the plats were replanted and excellent results finally obtained. It was so late before they could be replanted at Laramie that they did not ripen. However we are able to report an experiment with different amounts of oats per acre at this place, though as complete notes were not taken as in the special experiments with wheat and barley. This part of the experiment was to be conducted alike at the places mentioned. The general plan was to lay out small plats, 13x14 feet in size, planted in drills eight inches apart running diagonally across the plat. The plats were placed two feet apart each way. When about ready to harvest the edges of the plats were cut away in such a manner as to cross the drills diagonally leaving

the grain standing in a space ten feet, eleven inches by ten feet which would amount to 1-400 of an acre. This grain from around the edges was cast out as it would probably be better developed on account of the nearness of the unused paths. The rest of the plants in the plat would be more nearly like those in a field. A lath frame made two feet square was then placed over the grain in an average part of the plat and all the heads standing within carefully counted. Full notes were to be kept including records of the total amount of straw and grain produced in each plat. On account of the serious illness of Mr. Meyer notes on this part of the experiment at Lander have not been received.

LARAMIE.

Table I gives the results of the stooling test for 1896. Only twenty-five seeds were planted at one foot distances, but in order to compare with other distances in the table all computations were made for fifty seeds. This has been done in all the experiments carried out in 1896. The column

TABLE I.—*Laramie, 1896.*

50 Seeds Planted.

GRAIN.	Distance Apart, Inches.	Highest Grain, ft.	Average Height, ft.	No. Stools Formed.	No. Stems Formed.	No. Mature Heads.	No. Heads Smutted.	No. Mature Heads Per Stool.	Weight of Straw, oz.	Weight of Grain, oz.	Weight of Grain Per Stool, oz.
Chili Wheat.	1	3.8	3.6	38	262	218	18	5.7	18.5	11.5	0.30
	2	4.0	3.7	47	390	330	12	7.0	31.0	21.0	0.45
	4	3.9	3.4	44	707	423	9	9.6	38.0	23.0	0.52
	12*	4.5	3.7	44	1516	936	40	21.3	134.0	51.0	1.16
White Wonder Oats.	1	4.5	4.0	44†	195	177	21	4.0†	32.0	11.0	0.25
	2	4.2	3.9	38	278	203	47	5.3	32.0	13.0	0.34
	4	4.3	4.0	46	473	431	29	9.4	56.5	27.5	0.60
	12*	4.3	4.0	42	816	716	52	17.0	176.0	54.0	1.29
Manshury Barley.	1	3.3	3.0	43†	293	277		6.4†	19.5	13.5	0.31†
	2	3.4	3.1	40†	422	412		10.3†	32.5	26.5	0.65†
	4	3.4	3.1	41	682	638		15.6	55.0	41.0	1.00
	12*	3.3	2.9	44	1304	1292		29.4	160.0	72.0	1.64

*25 seeds planted this distance apart. Computed as 50 seeds for comparison.
†Number of stools not counted at time of harvest.

giving the number of stools shows the number of seeds planted which reached maturity in each case. In the grains planted one and two inches apart it was difficult to determine accurately the number of stools at the time of harvest. The number of seeds which germinated and came up minus those which were known to have died or were eaten off gives the correct number of stools harvested. In several instances where it was impossible to count the ripe stools this note has been inserted in the tables.

We realize that using so small a number of seeds and such small plats is open to criticism in experimental work. However it is easier to control conditions on small plats and we think the remarkably uniform results obtained in these trials show that when carefully conducted, such experiments may result in data of much value, allowing conclusions to be drawn which could hardly be reached in any other way.

Table II gives data obtained in 1897. One hundred seeds were planted in each test and at the end of the season fifty stools were selected in that part of the row where fewest of the seeds failed to grow, and as all the data given

TABLE II.—*Laramie, 1897.*

100 seeds planted. 50 stools selected for record.

GRAIN.	Distance Apart, Inches.	Height of Grain, ft.	No. Stems Formed in 50 Stools.	Length of Heads, ft.	No. Mature Heads.	No. Mature Heads Per Stool.	Weight of Straw, oz.	Weight of Grain, oz.	Weight of Grain Per Stool, oz.	
Chili Wheat.	1	all was	233	0.33	154	3.08	20.5	7.5	0.15	Wheat Badly frosted.—Ripe Sept. 22.
	2	3.3 ft.	551	0.37	273	5.46	34.5	15.5	0.31	
	4	to	646	0.35	292	5.84	41.5	13.0	0.26	
	12	3.4 ft.	1453	0.40	486	9.72	96.0	18.5	0.37	
Manshury Barley.	1	2.75	243	0.35	224	4.48	14*	12.0	0.24	Ripe Sept. 3.
	2	3.2	601	0.35	240	4.80	30.5	37.5	0.75	
	4	2.9	720	0.35	543	10.86	40 0	41.0	0.82	
	12	2.9	1583	0.40	523	10.46	71.5	36.5	0.73	

*Estimated. Chaff from heads was not weighed.

in the different columns was obtained from the same number of stools they may be compared with more confidence. The results at hand which can be averaged for the two years are somewhat meager. Studies of the average number of heads per stool and the amount of grain per stool obtained in 1896 and 1897 show that the general result would not be changed. The only effect of averaging the two years work seems to be to smooth out the irregularities and with the material at hand we do not consider tables showing such averages of importance. These averages are indicated in the charts following the tables.

The grain was planted May 8th. The barley and wheat were both up May 20th. The oats failed to come up as the vitality of the seed was injured by treating for smut in too strong solution of copper sulphate. They were replanted on June 11th but it was so late that they did not mature. The wheat and barley were irrigated July 3rd and July 29th. Barley began to ripen September 3rd. Killing frost September 17th injured the wheat, more especially that which was planted so far apart that it was late in ripening. All the wheat fell below fifty-six pounds per bushel.

Tables III and IV report the special tests with differerent amounts of wheat and barley per acre. The barley

TABLE III.—*Chili Wheat, Different Amounts of Seed Per Acre, Laramie, 1897.*

SEED PER ACRE, LBS.	Height of Grain, ft.	Length of Heads, ft.	No. Mature Heads in 4 sq. ft.	Weight of Straw, oz.	Weight of Grain, oz.	Straw, per Acre, lbs.	Grain per Acre, lbs.	Weight per Bushel, lbs.
120	4.4	0.30	164	240	64	6000	1600	55.5
110	4.1	0.33	102	232	64	5800	1600	54.5
100	4.0	0.27	105	180	68	4500	1700	54.5
90	3.7	0.27	99	232	64	5800	1600	55.5
80	4.0	0.26	109	256	64	6400	1600	54.5
70	4.0	0.27	102	236	68	5900	1700	53.5
60	4.0	0.27	110	244	52	6100	1300	54.5
50	4.2	0 30	103	236	68	5900	1700	
40	4.6	0.30	112	258	54	6437	1200	52.0
30	4.3	0.30	96	192	48	4800	1200	52.5

was not cut as soon as ripe and heavy winds caused the plats which were the ripest to shatter out badly. Careful estimates of the per cent of the grain which was lost by shattering are given in the last column of the table.

TABLE IV.—*Manshury Barley, Different Amounts of Seed Per Acre, Laramie, 1897.*

SEED PER ACRE, LBS.	Height of Grain, ft.	Length of Heads, ft.	No. Mature Heads in 4 sq. ft.	Weight of Straw, oz.	Weight of Grain, oz.	Straw, Per Acre, lbs.	Grain, Per Acre, lbs.	Weight Per bu. lbs.	Remarks.
120. .	3.4	0.3	148	152	64	3800	1600	49.0	*15 per cent shattered
110. .	3.5	0.3	87	122	54	3050	1350	47.0	15 per cent shattered
100 . .	3.5	0.3	91	128	48	3200	1200	47.5	12 per cent shattered
90 . .	3.5	0.3	126	144	48	3600	1200	46.5	12 per cent shattered
80 . .	3.5	0.3	78	125	51	3125	1275	46.5	10 per cent shattered
70 . .	3.5	0.3	81	111	49	2775	1225	46.5	8 per cent shattered
60 . .	3.6	0.3	76	127	49	3175	1225	47.0	8 per cent shattered
50 . .	3.6	0.3	65	105	43	2625	1078	46.5	3 per cent shattered
40 . .	3.7	0.3	81	149	59	3725	1487	48.0	2 per cent shattered
30 . .	3.9	0.3+	106	132	60	3300	1500	45.5	1 per cent shattered

*Per cents estimated.

Table V reports a field test upon different amounts of oats per acre. Each plat contained one-twentieth of an acre. The grain was sown with a press drill. By mistake the seventy pound plat and the eighty pound plat were harvested together. The table gives the average amount of straw and grain for each of these plats.

TABLE V.—*Lincoln Oats, Different Amounts of Seed Per Acre, Laramie, 1897.*

One-twentieth acre plat used in each case, and grain planted with press drill. In this respect being different from the barley and wheat.

SEED PER ACRE, LBS.	Yield Per Acre, Straw, lbs.	Yield Per Acre, Grain, lbs.
120	1778.6	1036.4
110	1704.4	1080.2
100	1190.2	1036.6
90	1321.1	1036.6
70 and 80*	1204.1	929.9
60	1567.1	1176.8
50	1676.8	1067.1
40†	2037.6	1255.1

*The two plats planted at the rate of 70 and 80 pounds per acre respectively were harvested together. The average yield is given.

†On outside near alfalfa.

The comparatively large yield from the plat sown at the rate of forty pounds per acre is due to the fact that it was next to a plat of alfalfa. The effect of alfalfa on the oats was quite noticeable and we do not think a comparison should be made between this and other plats. After cutting out this plat the results show the best yields from sixty pounds to the acre.

LANDER.

Table VI reports the results in 1896. Superintendent Meyer carried out the work in a most careful manner and furnished a most excellent report.

TABLE VI.—*Lander, 1896.*

50 seeds planted.

GRAIN.	Distance Apart, Inches.	No. Stools.	No. Mature Heads.	No. Smutted Heads.	No. Heads Per Stool.	Average No. Grains in Six Selected Heads.	Amount of Grain, oz.	Grain, Per Stool, oz.
Chili Wheat	1	37	354	7	9.75	67	20.0	0.54
	2	41	655	17	16.37	85	41.0	1.00
	4	44	931	26	21.75	88	70.0	1.59
	12*	36	690		19.16	113	60.0	1.67
White Wonder Oats.	1	44	295	22	7.20	99	25.0	0.57
	2	45	345	48	9.00	97	20.0	0.44
	4	45	584	33	13.71	118	100.0	2.22
	12*	32	628	92	22.50	141	94.0	2.94
Manshury Barley.	1	45	550	.....	12.22	56	31.0	0.69
	2	43	774	.....	18.00	66	53.5	1.24
	4	46	1616	.....	35.13	76	111.0	2.41
	12*	40	1466	.....	36.62	73	144.0	3.60

*25 seeds planted. Computed as fifty seeds for comparison.

The grains were planted May 13th and all were irrigated July 10th and August 13th. The wheat came up May 24th and 25th and was harvested September 18th. The largest number of heads in a stool of wheat was, 1 inch apart 18, 2 inches apart 45, 4 inches apart 43 and 12 inches apart 60. The White Wonder oats came up May 25th and were ripe September 7th. The largest number of heads in a stool

was, 1 inch apart 13, 2 inches apart 15, 4 inches apart 26, 12 inches apart 43. The Manshury barley came up May 25th to 29th and was ripe September 4th. The stools growing one inch apart were so close that the heads from each separate stool could not be counted. The largest number from a single stool planted 2 inches apart was 47, 4 inches apart 97 and 12 inches apart 74.

Table VII reports the results in 1897. It will be noticed that only about half the number of heads were produced per stool and half as much grain as was obtained the previous season. The wheat was planted May 12th and came up May 22nd, irrigated July 1st and 29th and ripe August 30th. The greatest number of stalks per stool was, 1 inch apart 16, 2 inches apart 40, 4 inches apart 32 and 12 inches apart 56. The barley was planted May 12th, came up May 19th, was irrigated July 1st and 29th and was ripe August 15th. The largest number of heads to a stool was, 1 inch apart 17, 2 inches apart 27, 4 inches apart 38, and 12 inches apart 55.

TABLE VII.—*Lander, 1897.*

100 seeds planted. 50 stools selected for record.

GRAIN.	Distance Apart, Inches.	Height of Grain, ft.	No. Stems.	Length of Longest Heads Inches.	No. Mature Heads.	No. Heads Per Stool.	Weight of Straw, oz.	Weight of Grain, oz.	Weight of Grain per Stool, oz.
Chili Wheat.	1	3.0		4.0	241	4.8	17	12.5	0.25
	2	3.3	481	4.5	400	8.0	32	19.5	0.39
	4	3.3	686	4.7	630	12.6	83	32.7	0.65
	12	3.2	1240	6.0	1032	20.6	136	53.0	1.60
Manshury Barley.	1	2.3	327	4.2	297	5.9	18.5	17.0	0.34
	2	3.0	646	4.5	548	10.9	73.0	38.0	0.76
	4	2.5	765	4.2	555	11.1	81.5	42.5	0.85
	12	2.9	1743	5.0	1341	26.8	244.0	123.0	2.46

SHERIDAN.

The farming land around Sheridan produces large yields of wheat and is especially noted for the large yields of oats which have been obtained there. However, the stooling test in 1896 reported in Table VIII gave no startling results. It seemed to be an "off season" and a shortage of water for irrigation caused complaint. The superintendent, Mr. J. F. Lewis, kept excellent records and furnished good reports of the tests for both seasons. It should be stated that the distance between the rows was twenty-eight inches instead of three feet as at other places. With so much distance between the rows it is doubtful if this difference would modify the results in any material way. The wheat was planted April 25th, came up May 8th, irrigated June 12th, July 6th and 30th and was ripe August 11th. The notes state that some of the heads were blighted but the cause was not apparent. The grain planted twelve inches apart did not ripen evenly. The barley was planted, came up and was

TABLE VIII.—*Sheridan, 1896.*

50 seeds planted.

GRAIN.	Distance Apart, Inches.	Height of Grain, ft.	No. Stools.	No. Mature Heads.	No. Heads Smutted.	No. Heads Per Stool.	Weight of Grain, oz.	Weight of Grain per Stool, oz.
Chili Wheat.	1	2.5	37	184	.....	4.97	9.5	0.26
	2	2.7	46	316	.....	6.87	16.5	0.26
	4	3.0	46	402	.....	8.74	19.5	0 42
	12*	2.3	40	324	.....	8.10	22.0	0.55
White Wonder Oats.	1	2.8	46	224	32	4.87	24 0	0.52
	2		47	182	72	3.87	20 5	0.44
	4		50	287	47	5.74	36.0	0.72
	12*		46	374	108	8.13	36.0	0.78
Manshury Barley	1	2.4	48	247	.....	5.14	24.0	0.50
	2	2.5	44	342	.....	7.77	2[illegible].0	0 64
	4		49	508	.....	10.37	48.0	0.98
	12*		44	730	.....	16.59	60 0	1.36

*25 seeds planted. Computed as 50 seeds.

irrigated on the same dates as the wheat. It was ripe August 1st. The notes state that the barley planted twelve inches apart did not ripen as evenly as that planted thicker. The oats were planted April 8th, came up May 10th and were irrigated on the same dates as the wheat. They were ripe August 10th. The seeds planted twelve inches apart produced shorter straw and less grain and ripened several days later than that planted thicker.

Table IX giving data for 1897 shows much better development and yields than were obtained in 1896. Planting was done May 5th. They were irrigated May 28th. June 15th, June 26th, July 7th, and July 30th. The wheat came up May 8th. That planted one inch apart was ripe August 20th, and that planted twelve inches apart was ripe August 28th with the exception of late stems around the outside of the stools. Straw was badly affected with rust, especially that which was thinly planted.

TABLE IX.—*Sheridan, 1897.*

100 seeds planted. 50 stools selected for record.

GRAIN.	Distance Apart, Inches	Height of Grain, ft.	No. of Stems formed in 50 stools.	Length of Heads, ft.	No. of Mature Heads.	No. of Heads per Stool.	Weight of Straw, oz.	Weight of Grain, oz.	Weight of Grain per Stool, oz.
Chili Wheat	1	3.2	375	0.33	303	6.0	70	48	0.96
	2	3.5	718	0.38	548	10.9	104	60	1.20
	4	3.2	650	0.38	572	11.4	103	94	1.88
	12	2.8	1050	0.38	750	15.0	152	82	1.64
Lincoln Oats (replanted)	1	3.2	372	0.83	325	6.5	56	35	0.70
	2	3.5	430	0.83	380	7.6	79	46	0.92
	4	3.3	484	0.87	447	8.9	85	71	1.42
	12	2.5	1036	. . .	734	14.7	120	52	1.04
Manshury Barley	1	3.2	509	0.25	480	9.6	56	44	0.88
	2	3.3	762	0.27	683	13.6	72	72	1.44
	4	2.3	981	0.21	801	16.0	88	85	1.70
	12	2.3	1295	0.21	900	18.0	121	87	1.74

The oats planted the first time did not grow and on May 25th they were replanted, the variety used being Lin-

coln. Those planted one inch apart were ripe August 20th and those planted twelve inches apart August 26th. The stools twelve inches apart rusted badly, causing light grain. The barley came up May 15th and was ripe August 4th, the straw being affected with rust. The superintendent writes "Rust seems to attack thin grain more than thick. Heretofore my observation has been the opposite. Thick grain gives more shade, allows less sunshine to enter and should be more liable to rust." I could not explain this unless as seems most probable it was due to the fact that the grain planted wide distances apart produced large succulent stems and a large growth of leaves near the ground, which remained green all summer, conditions which favor the growth of rust. I have noticed that winter grain planted in the spring would become badly rusted during the summer in the heavy green stools, while spring grain which had few leaves near the base of the stems would be almost or quite free from the disease. I may note here also that the number of smutted heads was greater upon the stools growing farther apart. This may be due to the fact that more heads are produced where more room is given and that the source of infection is with the seed from which the stool grows.

Tables X, XI and XII give the results of the special test of different amounts of seed per acre of wheat, barley and oats respectively. Each grain was treated the same except that the oats had to be replanted. The plats were placed upon old orchard ground which had been manured by mulch placed around the trees in winter. The trees had died and been removed. Mr. Lewis says it was a wonder to the visitors how he could raise such grain as the thirty pound plats produced. He says that the farmer who has not tried it does not realize what can be done upon our soils with manure and cultivation.

The wheat was planted May 4th, up May 8th, irrigated May 23rd, June 14th, 26th, July 7th and 30th. The grain

was ripe August 20th. The plat planted with 90 pounds of seed per acre was damaged by a ditch breaking and water soaking the ground. The barley plats were planted May 4th, came up May 12th, were irrigated May 23rd, June 15th, 26th, July 7th and 30th. The grain was ripe August 5th. Upon the thirty pound plat the heads seemed to ripen before the straw. The straw appeared green several days after the heads were fully ripe. The thickly sown plats were very ripe when cut, while those sown somewhat thinly were not fully ripe. The oat plats were resown on May 20th with Giant Side oats. They were irrigated and otherwise treated as the wheat and barley plats. The grain was ripe August 24th.

TABLE X.—*Chili Wheat. Different Amounts of Seed Per Acre. Sheridan, 1897.*

SEED PER ACRE, Pounds.	Height of Grain, ft.	Length of Heads, ft.	No. of Mature Heads in 4 sq. ft.	Weight of Straw, oz.	Weight of Grain, oz.	Straw per acre, lbs.	Grain per acre, lbs.
120	3.5	0.27	134	182	120	4800	3000
110	3.6	0.25	128	152	132	3800	3300
100	3.6	0.26	113	188	133	4700	3225
90	3.6	0.27	109	160	120	4000	3000
80	3.5	0.27	105	180	132	4500	3300
70	3.6	0.27	. . .	212	144	5300	3600
60	3.6	0.27	103	184	146	4600	3650
50	3.6	0.33	99	196	140	4900	3500
40	3.6	0.37	93	192	136	4800	3400
30	3.7	0.40	88	132	131	5800	3275

TABLE XI.—*Manshury Barley. Different Amounts of Seed Per Acre. Sheridan, 1897.*

SEED PER ACRE. Pounds.	Height of Grain, ft.	Length of Heads, ft.	No. of Mature Heads in 4 sq. ft.	Weight of Straw, oz.	Weight of Grain, oz.	Straw per acre, lbs.	Grain per acre, lbs.
120	3.2	0.25	138	123	129	3075	3225
110	3.3	0.27	134	114	134	2850	3350
100	3.3	0.27	130	140	156	3500	3900
90	3.5	0.25	128	140	156	3500	3900
80	3.3	0.25	124	140	156	3500	3900
70	3.3	0.25	121	160	161	4000	4025
60	3.4	0.27	120	126	146	3150	3650
50	3.4	0.29	105	164	140	4100	3500
40	3.2	0.27	103	123	134	3075	3250
30	3.3	0.27	102	100	116	2500	2900

TABLE XII.—*Giant Side Oats (Replanted). Different Amounts of Seed Per Acre. Sheridan, 1897.*

SEED PER ACRE, Pounds.	Height of Grain, ft.	Length of Heads, ft.	No. of Mature Heads in 4 sq. ft.	Weight of Straw, oz.	Weight of Grain, oz.	Straw per acre, lbs.	Grain per acre, lbs.
120	3.3	0.75	162	223	154	5575	3850
110	3.3	0.75	155	186	134	4650	3350
100	3.3	0.75	140	205	146	5125	3650
90	3.5	0.77	138	120	139	5500	3275
80	3.5	0.79	130	239	145	5975	3625
70	3.9	0.79	121	219	133	5537	3325
60	4.1	0.83	107	200	136	5000	3400
50	4.0	0.87	100	213	125	5725	3125
40	4.0	0.92	80	192	128	4800	3200
30	4.0	0.92	77	150	118	3750	2950

SUNDANCE.

The stooling experiment was only conducted one year at Sundance the results of which are given in Table XIII. The superintendent having this work in charge was Mr. A. E. Hoyt. This is the most humid section of the state and the only farming district in which crops are raised without

TABLE XIII.—*Sundance, 1896.*

50 seeds planted.

GRAIN.	Distance Apart, inches	No. of stools formed	No. of heads formed	No. of heads smutted	No. of heads per stool	Weight of Grain, oz.	Weight of Grain per stool, oz.
Chili Wheat	1	45	222	0	5.0	12	.27
	2	47	354	22	7.5	18	.38
	4	40	620	13	15.5	32	.80
	12*	38	876	50	23.0	56	1.47
White Wonder Oats	1	49	166	44	3.4	7	.14
	2	44	248	31	5.6	14	.32
	4	47	280	122	6.0	16	.34
	12*	46	520	68	11.3	64	1.30
Manshury Barley	1	42	212	. . .	5.0	12	.29
	2	45	276	. . .	6.1	20	.44
	4	45	538	. . .	11.9	40	.89
	12*	42	1436	. . .	34.2	88	2.09

*25 seeds planted this distance apart. Computed as 50 seeds for comparison.

irrigation. All the seeds were planted April 28th upon ground which had not been fertilized. The wheat came up May 7th and was ripe about August 12th. The barley came up May 7th and was ripe about August 6th. The oats came up the same date and were ripe August 10th. The plants from seeds planted greater distances apart were harvested later in each case than those planted close together.

WHEATLAND.

The work upon the Wheatland farm was carried out only one season. The superintendent, Mr. M. R. Johnston, took much interest in the stooling experiment. We report the results obtained in Table XIV. The wheat was planted May 7th when the ground was very dry. It was irrigated May 29th, June 9th, 29th and July 15th. It was harvested August 1st. Comparatively few stems formed in the wheat which did not mature heads. The barley was planted April 7th, irrigated May 29th, June 7th, 29th, and July 25th. It was harvested August 7th.

TABLE XIV.—*Wheatland, 1896.*

50 seeds planted.

GRAIN.	Distance Apart, Inches.	No. of Stools Formed.	No. of Stems Formed.	No. of Mature Heads.	No. of Heads Smutted.	No. of Mature Heads per Stool.	Weight of Straw, oz.	Weight of Grain, oz.	Weight of Grain per Stool, oz.
Chili Wheat	1	33	253	250	0	7.6	18	17	0.51
	2	45	450	446	0	9.9	19	32	0.71
	4	43	735	750	0	17.4	32	40	0.93
	12*	46	1030	1010	0	21.9	84	80	1.74
White Wonder Oats	1	38	339	260	56	6.8	23	20	0.53
	2	45	472	456	88	10.1	34	24	0.64
	4	48	640	520	106	10.8	35	49	1.02
	12*	44	1134	1004	60	22.8	94	100	2.27
Manshury Barley	1	22	263	230	0	10.4	13	16	0.73
	2	36	648	583	0	16.2	31	35	0.97
	4	42	848	796	0	18.9	55	49	1.17
	12*	34	1144	1060	0	31.2	122	84	2.47

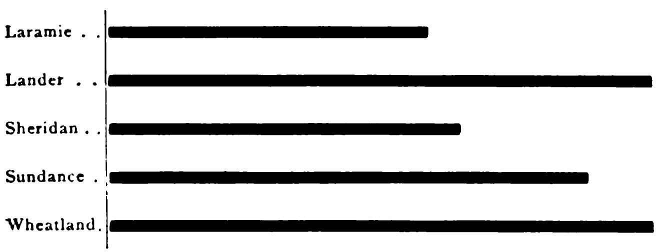
*25 seeds planted this distance apart. Computed as 50 seeds for comparison.

GRAPHIC PRESENTATION OF THE RESULTS GIVEN IN THE TABLES.

The lines represent averages of the number of heads and the amount of grain produced under all conditions in each locality. The results for two seasons at Laramie, Lander, and Sheridan have been averaged. With oats only one season's work was done except at Sheridan, where the results of two seasons are averaged. The lines for the different kinds of grain are drawn to the same scale so either the number of heads or the yields of each may be compared. As the same amount of land was used in each case the lines represent corresponding yields for equal areas.

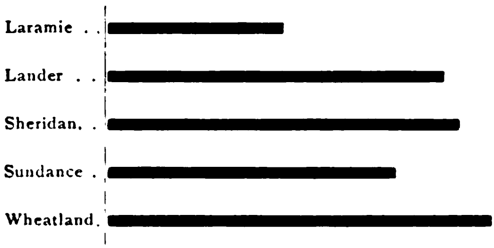
WHEAT.

Tillering shown by the average number of heads produced at each place. Wheatland and Sundance are for one season, other places represent averages for two seasons.



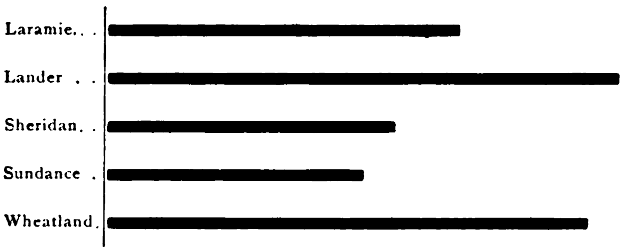
WHEAT.

Tillering shown by average yield of grain under all conditions. Wheatland and Sundance are for one season, other places represent averages for two seasons.



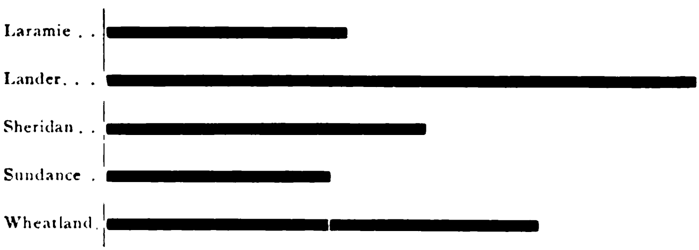
OATS.

Tillering shown by the average number of heads produced under all conditions. At Sheridan average is for two seasons, other places for one season.



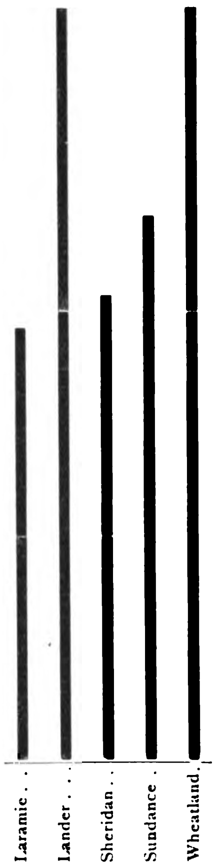
OATS.

Tillering shown by the average yield of grain under all conditions. At Sheridan average is for two seasons, other places for one season.



BARLEY.

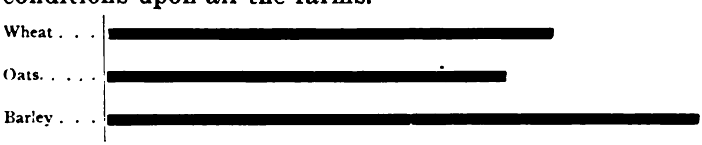
Tillering shown by the average number of heads produced under all conditions. Wheatland and Sundance for one season, other places represent averages for two seasons.



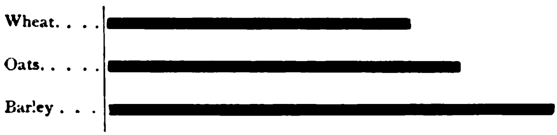
BARLEY.

Tillering shown by the average yield of grain under all conditions. Wheatland and Sundance for one season, other places represent averages for two seasons.

Comparative tillering of wheat, oats and barley as shown by the average number of heads produced under all conditions upon all the farms.



Comparative yields of wheat, oats and barley as shown by the average yield of each under all conditions and upon all the farms. We are often asked what grain to plant upon a small piece of ground to get the largest yield in any one season. This shows that under the average conditions in the state barley will produce the heaviest yield, i. e. the greatest weight of grain per acre, oats second and wheat third.



EFFECT OF ALTITUDE ON STOOLING OF GRAINS.

We have shown the difference in tillering power and yield of wheat, oats, and barley at each of the sub-farms. Because of the great difference in the natural conditions, especially of soil, in the different sections of the state it would be difficult to assign reasons for the difference in tillering and yields. Therefore a general comparison of these results merely indicates the relative amounts of grain which may be expected in each place.

No doubt the kind and condition of the soil has a most important influence, and grain raised upon a characteristic soil, as that at Sheridan for example, could not be compared with that grown upon an entirely different soil in order to assign difference in growth or yield to some other cause. Difference in fertility causes difference in number of heads produced by each seed.*

So far as we have been able to ascertain the conditions at Wheatland and Laramie in 1896 were very nearly the same except those due to difference in altitude and we venture to make a comparison of the stooling of grains at

*Recent experiments in Russia by D. N. Pryanishnikov and S. M. Kouznezov with barley show that the number of stems producing heads increased with the increase of nitrogen supplied in the form of sodium nitrate. Exp. Sta. Record, vol. IX, p. 741.

these places, believing that it indicates in a general way the influence of altitude upon their tillering capacity. Difference in conditions due to altitude are largely those appertaining to temperature and difference in air pressure At high altitudes the nights are colder and the seasons shorter than at low ones, variations which have an important effect on plant growth. The loss of moisture from plants through transpiration differs with change in intensity of light, change in temperature of the air, and the moisture in the air, and change in the pressure of the air itself.* Therefore differences in altitude along with the variations in climate would be expected to produce appreciable effects upon plant growth.

The altitude of the Laramie farm is approximately 7,200 feet while that at Wheatland is 4,700 feet, giving a difference of 2,500 feet.

The soils of the Laramie and Wheatland farms are almost identical.†

The two farms are located about sixty miles apart. Both have the same conditions of exposure, being out on the open plain away from the protection of surrounding hills and mountains. The climatic conditions other than those due to difference in altitude are much the same.

Table XV gives the data obtained in the stooling tests at Wheatland and Laramie in 1896. It will be noticed that more heads per stool and more grain were produced at the lower altitude. Taking averages of the heads and grain raised under all the conditions at the two places gives us with wheat a difference of 3.3 heads per stool in favor of Wheatland and 0. 27 oz. more of grain. With oats there were 3.7 more heads and .47 oz. more grain per stool at Wheatland With barley there were 3.8 more heads and

*See Wyo. Sta. Bul. 15.

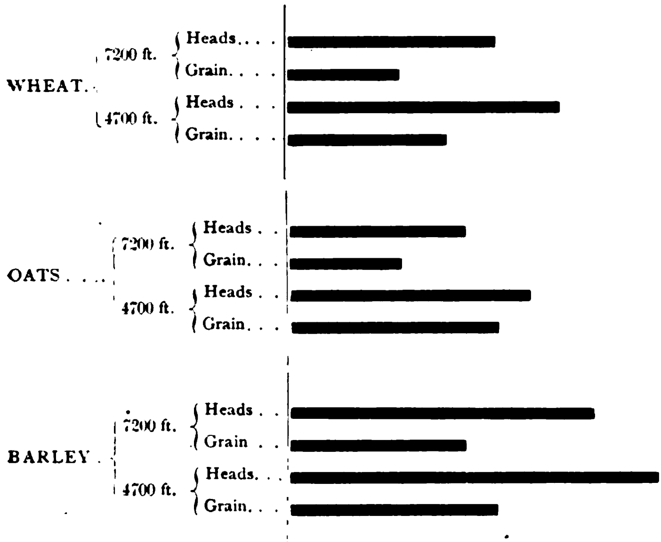
†See chemical analyses, Wyo. Sta. Bul 6, pp. 16 and 21; Geological Origin of the Soils, Wyo. Sta. Bul. No. 14. pp. 105 and 116; Mechanical Analyses of the Soils, Wyo. Sta. Bul. 35, pp. 165 and 173, and plates showing proportional amount of different sized soil particles, also chart, p. 183.

TABLE XV.

	50 seeds 1 inch apart.					50 seeds 2 inches apart.					50 seeds 4 inches apart.					50 seeds 12 inches apart.				
	No. of Stools.	No. of Heads.	Heads per Stool.	Amount of Grain, oz.	Grain per Stool, oz.	No. of Stools.	No. of Heads.	Heads per Stool.	Amount of Grain, oz.	Grain per Stool, oz.	No. of Stools.	No. of Heads.	Heads per Stool.	Amount of Grain, oz.	Amount of Grain per Stool.	No. of Stools.	No. of Heads.	Heads per Stool.	Amount of Grain, oz.	Amount of Grain per Stool.
WHEAT.																				
Laramie, 7200 ft. . .	38	218	5.7*	11½	0.30	47	330	7.0	21	0.45	44	423	9.6	23	0.52	44	936	21.3	51	1.16
Wheatland, 4700 ft. .	33	250	7.6	17	0.51	45	446	9.9	32	0.71	43	750	17.4	24	0.56	46	1010	21.9	80	1.74
OATS.																				
Laramie, 7200 ft. . .	44*	177	4.0*	11	0.25*	38	203	5.3	13	0.34	46	431	9.4	27½	0.60	42	716	17.0	54	1.29
Wheatland, 4700 ft. .	38	260	6.8	20	0.53	45	456	10.1	24	0.53	48	520	10.8	49	1.02	44	1004	22.8	100	2.27
BARLEY.																				
Laramie, 7200 ft. . .	43*	277	6.4*	13½	0.31*	40*	412	10.3	26½	0.65*	41	638	15.6	39	0.95	44	1292	29.4	72	1.64
Wheatland, 4700 ft. .	22	230	10.4	16	0.73	36	583	16.2	35	0.97	42	796	18.9	49	1.17	34	1060	31.2	84	2.47

*Number of stools given from notes of the number of seeds which came up after deducting number of plants which died or were eaten off during the season. Other stools counted when harvested.

.44 oz. more grain per stool at Wheatland. These differences are shown graphically in the following chart in which one inch length of the heavy horizontal lines is allowed to represent ten heads per stool or one ounce of grain per stool.



It seems fair to assume that the difference exhibited in the stooling power of these grains may result directly or indirectly from the conditions due to the great difference in altitude.

EFFECT OF IRRIGATION ON STOOLING.

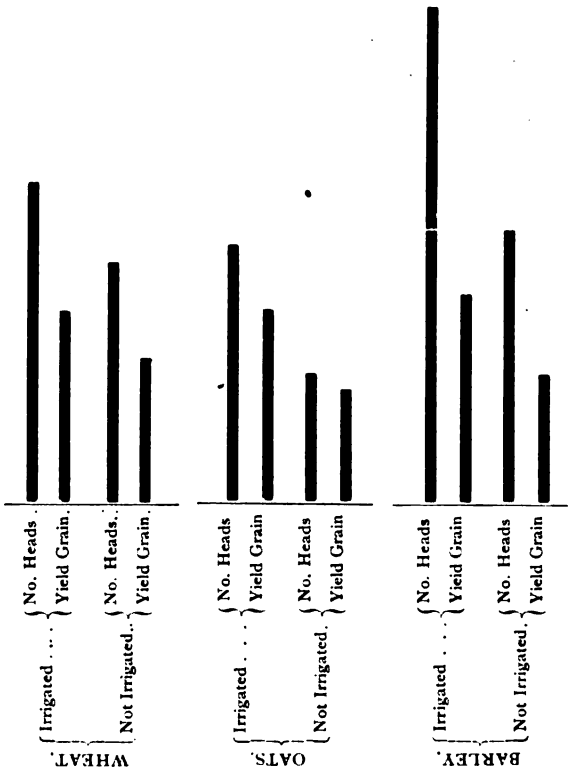
We are fortunate in being able to compare irrigated grain with that raised without irrigation in two places which are much alike in soil and general climatic conditions. As there may be conditions of which we are not aware that would produce important effects upon plant growth the results must be taken with some allowance, but we believe that this data illustrates the effect of irrigation in a way that is interesting and instructive and that some reliance can be placed on the general result.

It would be difficult to find two places one in a semi-humid and the other in an arid region which are more nearly alike in other important conditions than the Lander and Sundance farms. The altitude differs by about 1,000 feet, Lander being higher than Sundance. This difference in altitude probably has its effect upon the stooling of these grains, but according to our present information the stooling is diminished with increase of altitude. Therefore this difference rather helps out the validity of the results.

The average rainfall at Sundance exceeds that at Lander by about seven and three-fourths inches. The rainfall at Sundance is a little over twenty-one inches, and crops are raised without irrigation. The rainfall at Lander is about thirteen and one-half inches and irrigation is necessary for all crops. Both farms are surrounded by hills and mountains which protect them. While Lander is at a higher altitude, the mean annual temperature is also a little higher, being 43.7 degrees F., compared with 41.2 degrees at Sundance. (See Wyo. Sta. Bul. No. 27). The soils of the two places are very much alike. They are derived from the same geological horizons (see Wyo Sta. Bul. No. 14.) and are almost identical chemically and mechanically, (see Wyo. Sta. Buls. No. 16 pp. 17 and 20 and Bul. No. 35).

We compare the stooling in 1896 at the two places in Table XVI. At Lander the grains were irrigated twice, June 10th and August 13th. As before said the treatment of the soil, planting and treatment of the crops were the same at both places. With wheat there was a difference in favor of irrigated grain of four heads per stool and 0.47 oz. of grain per stool; with barley the difference was 6.5 heads per stool and 0.99 oz. per stool of grain.

With oats the difference was 11.2 heads per stool and 0.87 oz. grain per stool. The results can be illustrated in the following way allowing one inch of heavy horizontal line to represent 10 heads or one ounce of grain.



The principal reason irrigation produces this effect is obvious. As a rule the grain is not irrigated until the tillers have formed. Up to this time there would be little difference in growth. Irrigation at the proper time supplies the needed moisture along with some plant food and makes other plant food available to such an extent that the tillers which have formed are stimulated to the greatest possible growth causing a maximum number of heads to mature. The grain which is not irrigated matures the number of heads for which there is food and moisture leaving the remainder of the shoots undeveloped.

Under these conditions can grain be grown with profit to the producer?

Yes, early varieties produce good crops of most excellent grain. Three years' experiments growing grain on a small scale at Laramie showed a profit of $8.88 per acre. Oats will bring even a better return, and barley succeeds better than either. Barley, when ground with other grain, is very valuable for feed, and our brewing barley is of the best quality. It requires but a short season. We have experienced no difficulty in ripening all varieties.

How can planting the grain early enough in the spring be accomplished?

By fall plowing. Our open falls give ample time for plowing after the crop is off. We recommend as deep plowing as possible and leaving the ground rough. In the spring harrow thoroughly before sowing the grain.

Will not the winter winds blow the loosened soil away?

One would think so, but we have had no difficulty of the kind. The ground is often so dry in the fall that it cannot be plowed. In such an event if water can be had the land should be irrigated thoroughly before plowing. Plowing in the fall retards evaporation during the winter and much of the water supplied by fall irrigation will be available to start the crop in the spring.

Will winter wheat succeed?

Not as a rule. At Laramie we have never been able to make winter wheat stand the drouth of winter. Winter rye succeeds well.

When should grain be planted?

As early in the spring as the frost is out of the ground. Even early varieties planted after the middle of May are apt to be frosted before they mature.

Do you recommend any special method of sowing grain?

Yes, the best results are obtained when the press drill is used. We use a shoe drill with wheels behind which press the soil around the seed, insuring germination and growth. The disk press drill will probably work better than the shoe drill on sod ground but we cannot speak of its use from our own experience. Broadcasting and harrowing in the grain is wasteful of seed, secures comparatively poor results, and is altogether out of date.

Will not using a heavy roller on land after sowing the grain with an ordinary hoe drill or other method do as well as using the press drill?

A roller should never be used on our soils, where it is necessary to save all the moisture possible. Leaving the surface smooth from rolling allows the most rapid loss of water by evaporation. If the roller is ever used to break lumps or for any other purpose, the surface should be broken up immediately afterward with a harrow or cultivator.

Will not broadcasting the grain and plowing under secure as good results?

Only under the most favorable conditions. The grain cannot be sown so evenly, it is apt to be covered too deep and there are no defined drill rows which allow free entrance of light and circulation of the air. However, plowing shallow to cover the grain is better than covering with the harrow.

What varieties do you recommend?

Any of the early standard varieties. We are growing all the varieties we can obtain with the hope that something may be found even better than the varieties that have already proven successful. Velvet Chaff or Blue Stem and the Fife wheats require a little longer season than we generally have here and they shell badly when ripe. Varieties of wheat which have succeeded best are, Defiance, White Russian, Amethyst, Australian Club, Chili, and such feeding sorts as Polish, Seven Head, and Pride of America.

A good feeding barley is Nepaul, which is both beardless and hulless. Good brewing sorts are, the Mansbury, which is six-rowed, and Chevalier, Vermont Champion and Highland Chief in the two-rowed sorts. The Chevalier and Vermont Champion barleys drop their beards when the grain is ripe. The Chevalier is an especially fine variety but it must be cut at just the right time to prevent loss by shelling.

Varieties of bush oats seem to be earlier than varieties of side oats. The side oats, being late, grow the full length of the season and on this account are probably better to plant where they are intended to be cut for hay, as they produce a large amount of straw. The Bonanza seems to be especially fine for this purpose. Bush oats are recommended for the production of grain. Lincoln, Surprise, White Wonder and Clydesdale are excellent varieties.

Is it advisable to treat the seed before planting?

We have not been bothered to any extent with smut in barley, but wheat and oats should be treated unless it is known that the seed is clean. (For methods of treatment see Wyo. Sta. Bul. No. 21).

How many irrigations are necessary?

That depends upon so many conditions that no rule can

be given. At low altitudes, as at Sheridan, the grain is often irrigated five times. On the Laramie plains good crops are frequently secured with one or two irrigations. Sod land requires much more water than that which has been cultivated a number of years.

When should grain be harvested?

As a general rule when it is in the thick dough. With us the head ripens before the straw. If left till the straw is ripe the grain is apt to shell badly from winds. If harvested while the straw is still green the shocks should not be made too large as there might be some danger of the grain heating and spoiling.

Does it pay to put stable manure on land for grain?

Yes, if a light dressing can be put on at a moderate cost. One season we found that putting on stable manure at the rate of twelve loads, of about one ton each, per acre increased the yield of wheat from thirty-two to fifty bushels per acre. On large areas of land we believe there are rotations with leguminous crops which will keep up the soil fertility cheaper than by the use of manure.

What would be a good rotation for the Laramie plains?

A good four- year rotation would be: First year peas, second year grain, third year potatoes, and fourth year grain. A good six or seven year rotation would be: Alfalfa three years, fourth year grain, fifth year potatoes, sixth or sixth and seventh years grain. We find that growing peas for only one year makes a wonderful difference in the yield of grain, and alfalfa is a noted improver of the soil.

Should one of the cereals follow another on the same land?

Not if you wish to keep the seed clean and unmixed. All the seed which is left on the ground from one year's crop seems to grow the next season, so if grain is to be planted two years in succession on the same land, the same variety should be used.

Which of the grains is most apt to succeed upon land which begins to show alkali coming to the surface?

Rye will stand more alkali than other grains. In the field there is but little difference between the other grains, though wheat and barley seem to germinate in stronger alkali than oats. Upon land which is becoming affected by the rise of alkali to the surface, instead of planting grain of any kind, unless there is too much alkali, we would recommend planting alfalfa, which is a deep-rooted plant and which will keep the ground shaded a larger part of the time, preventing evaporation and the rapid accumulation of salts upon the surface.

What is the meaning of stooling and tillering as used in this bulletin?

As here used the two terms are synonymous. Tillering means the throwing out of additional stems or branches, often called "suckers," from the crown of the plant. This produces the stool, which consists of the total number of stems growing from a single seed.